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[OFFICIAL NOTICE.]

Cost of Proceedings, Western Gas Association, to Non-Members.

WESTERN GAS ASSOCIATION, OFFICE OF THE SECRETARY, NEW ALBANY, IND., Sept. 29, 1899.

Bound copies containing the Proceedings of the Western Gas Association for the years 1896-97-98 can be obtained for the sum of $2 each. Make your remittances payable to the Secretary.

JAMES W. DUNBAR, Secy.

BRIEFLY TOLD.

DEATH OF MR. DAVID BRUCE PEEBLES.—In these times of queer international complications it may seem undiplomatic to speak well of anyone, for fear that the one spoken of may have short official tenure; but as sorrow spurs harder and longer than anger, and as it is a satisfaction to bear testimony to the right virtues of the dead, we will chance the introductory remark that all the fraternity will join in sincerely regretting the death of Mr. David Bruce Peebles, whose well directed labors in life were completed when death summoned him, the morning of Tuesday, the 5th inst. For months he suffered, not in the struggling sense, but through the keen vitality that keeps those alive who prefer to let nature take its course. Perhaps not two score American gas men will remember the kindly, bristling, honest Englishman who came to study our American gas methods in 1880, but those who met him then will well now recall that he was of the fraternity—ready to impart of his fund of knowledge, eager to accept in return the teachings of those with whom he counselled. Although his mission to this country, from a commercial standpoint, which mainly meant the popularization here of the famous "Peebles needle governor burner," was not successful, it remains that, if his commerce was not extended his personality was appreciated and esteemed. Perhaps the following obituary note regarding him, which appeared in the columns of the *Gas World* for the 9th inst., may be accepted as the record of truth respecting the way they thought of him at home—and for our part we say not a word or a thought in the mention is beyond that which is due him: "Widespread regret will be experienced throughout the gas profession at the news of the death of Mr. David Bruce Peebles, of the Tay works, Bonnington, Edinburgh, which occurred on Tuesday. And this regret will be shared by a wider circle, for Mr. Peebles was well known in the engineering and electrical world, and had the faculty, in a pre-eminent degree, of making and retaining friends. His kindly, hospitable and friendly bearing, his devotion to his work, his thoughtful thoroughness in whatsoever he undertook, and his enterprising spirit, all contributed to render him a man of mark in many ways; and he will be greatly missed. Any who have had the privilege of knowing him, both in business and in his kindly domestic circle, will feel that Mr. Peebles was a true man in every sense of the term. His career was one of steady devotion to thorough hard work and to a broad-minded and intelligent development of the gas industry, which owes him much. Born in Dundee in 1826, he spent his youth in his native town, where he served his apprenticeship as an engineer in the works of Messrs. Umpherston

& Kerr. After several years spent in the locomotive works at Swindon and at Amiens, he returned to Scotland, where he became a partner in the firm of Messrs. Fullarton & Co., gas meter manufacturers, Edinburgh. In 1866 he left that firm and started business on his own account in Fountainbridge, Edinburgh, and succeeded so well that he soon found the premises too small for him and shifted to new works, which he erected at Bonnington. They have had to be steadily enlarged, and the name of the Tay works, as Mr. Peebles called them, in remembrance of his boyhood's days, has become well known through the needle governor burners and other inventions issued from time to time from them; and not only through these, but through the products of the electrical department, which was added only two years ago, but which has already grown to be one of the largest electrical engineering works in Scotland. The thoughtfulness, care and enterprise which actuated Mr. Peebles in his business career perhaps themselves prevented him from taking any active or prominent part in public life; but he was in his element at the Royal Scottish Society of Arts, of which he was a Past-President, and at the meetings of the Royal Society of Edinburgh, of which he became a fellow, in the year 1886, and to the 'Transactions,' to which he was a contributor. The Gas Institute, too, will miss his genial presence, and his participation in its discussions. He leaves a grown-up family of three sons and four daughters. Two of the sons are partners in the business founded by Mr. Peebles."

NOTES.—The Waukegan (Ills.) Gas Company proposes to pipe the streets of the adjoining district of Lake Forest, so far as the west section of the latter is concerned.——A visitor to the Coatesville (Pa.) district just now could not fail of being convinced that the new proprietors of the Coatesville Gas Company mean business, if a general ripping up all round may be accepted as an indication of such purpose. Quite some money will have to be expended before the Coatesville gas plant will be up to the requirements of all those who want to avail themselves of its product.——Mr. Carl D. Bradley has been appointed to a responsible position in connection with the affairs of the American Gas Company, of Philadelphia. He likely will represent the Company on the road, his permanent headquarters being in the main offices at Philadelphia. Messrs. McCullough, Ramsdell and Stroud have in their selection of Mr. Bradley, secured a road agent who will hold the American Gas Company's end well to the front. That "Carl" is all right anyone who ever knew him must gladly testify.——We are in receipt of a copy of the work, by Mr. Jas. B. Dill, entitled "Dill, on New Jersey Corporations." This book, which is now in its second edition, is published by Messrs. Baker, Voorhis & Co., of New York, and should be invaluable to those connected with corporations owing their lives to the laws of New Jersey, or to others who contemplate involving themselves in similar meshes.——The proprietors of the St. Catharines and Welland Canal Gas Light Company, of St. Catharines, Can., have agreed to an increase in the capital stock of $35,740. The present capitalization is $130,000.——The customers of the Denver (Col.) Consolidated Electric and Gas Company complain over the proposition of the Company to charge a meter rate, instead of a flat rate, from Jan. 1st. Nor is it much wonder that murmuring is heard. Heretofore, electric light in Denver was sold on any old basis, the consumer being the judge as to whether or not he was abusing the flat rate. A little counting now and then is in line with good business management.——The proprietors of the Media (Pa.) Gas Company have declared a dividend of 3 per cent. out of the earnings for the past half year. The Company has arranged for important main extensions next season.——The authorities of Philadelphia have agreed to sell to the highest bidder the site heretofore occupied as a manufacturing station, on old city gas works municipal account, at 23d and Market streets. A good guesser as to the purchaser would likely be the one who named the Pennsylvania Railroad Company as such.——The new storage holder of the Fairbault (Minn.) Consolidated Gas and Electric Light Company, which was constructed by the Stacey Manufacturing Company, was successfully tested and put at work some days ago.——We understand that the Board of Gas Trustees, Wheeling (West Va.) Municipal Gas Works, has awarded the contract for the tar produced on the works for the ensuing year to the Cambria Steel and Iron Company, of Johnstown, Pa. The price agreed on was 4.60 cents per gallon.——The American Investment Company, which recently secured control of the gas and electric lighting interests of Mount Holly, N. J., also controls the electric lighting plants in the nearby districts of Moorestown and Haddonfield.——The Board of City Commissioners, of Youngstown, O., is debating the wisdom of abandoning the moon table schedule under which the lighting of the streets is performed. The matter would not seem to require extended consideration. All night and every night lighting should be the practice in any community that can pay its bills.

Modern Improvements in the Plant of Gas Works: Especially with Reference to the Saving of Manual Labor.

By MR. J. T. WESTCOTT.

A brief survey of earlier works will enable us to appreciate more clearly the present labor saving machines. Formerly coal was delivered in carts drawn by horses and stored in the yard or in coal sheds, from whence it was drawn in barrows by men to the retort house and shovelled into the retorts. Manual labor was employed to draw the charge of hot coke from the retorts and quench it with buckets of water or by turning on a hose. It was then wheeled into the coke yard, and, if caked, broken by hand with shovel and hammer.

The method of dealing with the gas from the time it left the retorts until it reached the consumer required much labor; the washing, scrubbing and purifying being all parctically accomplished without machinery. The purifying medium, usually lime, was placed in and discharged from the boxes in the crudest manner requiring the maximum amount of manual labor.

The methods of dealing with the residuals from the gas were equally crude. The modern chemical plants for dealing with the ammonia, sulphates, cyanides and the utilization of the tar at the works were almost unknown.

With the rapid strides that have taken place in the arts and sciences, an equally rapid evolution has proceeded in the method of manufacturing gas, until we find the modern gas works equipped with improvements and labor-saving devices which Mr. William Murdoch and Mr. Samuel Clegg would scarcely have pictured in their most sanguine dreams.

The retort setting for coking the coal has gradually increased, from one cast iron retort, to settings of 6, 7, 8, 9, and even 10 to 12 clay retorts. Instead of being heated by direct firing, the regenerative method of heating is usually adopted, whereby the heat from the products of combustion is utilized before passing into the stack.

This great advancement in retort settings is only an example of the improvements that have taken place in all other branches pertaining to the manufacture of gas. The numbers of patents for improvements in gas machinery, which have been filed in the archives of the patent offices of different countries during the past few years, have been legion. It is not within the scope of this paper to give a detailed description of all the various types of machines used in gas works at the present time, but a general idea of the methods employed to reduce manual labor.

The principal saving in labor being found in the retort house, we will consider gas works under the following heads: 1, horizontal retorts operated by manual labor; 2, horizontal retorts, machine charged and drawn; 3, inclined retorts, gravity charged and drawn; 4, combined retorts and carburetted water gas plant.

The first sub division would hardly come within the range of this paper, except where recently the advantages of scoop charging and manual charging and drawing machines have been appreciated, even in small works. The scoops are usually arranged in a carrier suspended, from an overhead trolley, by means of a chain pulley, thus allowing the scoop to be taken to any point in front of the several beds of retorts and raised or lowered to the height of any one retort.

The scoop is usually of steel, made in a half-circle, and provided at the end with a small roller. It can be taken on a little wagon to the coal store, filled and taken back to the retort house, where it is placed on the carrier and charged. A roller in front of each retort permits of ease in manipulating. A still better arrangement is where the scoop is allowed to run, by means of an overhead trolley system, from the coal store to the retort house and back again, not allowing it to be taken from the carrier to the wagon. This method is said to reduce somewhat the cost of the labor of carbonizing per ton, and an unskilled laborer can become a very efficient charger in a short time.

The manual charging machines and drawing machines are frequently worked in conjunction with conveyors, hereafter described, and at works larger than those where a scoop charger is used.

There are various types of manual charging and drawing machines, which vary in details, but accomplish the same purpose. Some charging machines are made with adjustable hoppers and others with fixed hoppers, all for the same purpose, and briefly as follows:

The manual charging machine is a square, upright frame on wheels, running on tram lines, laid parallel to and in front of the retort bench. On one side of this machine is a hand-wheel and gear, by means of which it is propelled; on the other side is another hand-wheel and gearing for hoisting and unloading an adjustable coal hopper from one tier of retorts to any other.

The coal supply for the retorts is received into the adjustable coal hopper on the charging machine, from overhead fixed coal hoppers.

The adjustable hopper being suspended by chains, is free to move vertically between the four uprights of the frame. The charger, when out of the retort, rests on a light frame suspended from the coal hopper. Directly over the charger, at the bottom of the hopper, is a feeder box for supplying the charger with coal.

The charger consists of a light carriage, running on three wheels, having two semi-circular scoops at the bottom. The scoops are arranged to turn over in opposite directions, by the twisting of a long driving rod, about half way around in one direction. This charger goes half the length of the retort at one time, and goes in the retort twice for a complete charge. A movable platform is used for working the top tiers of retorts.

The drawing machine is similar to the charger, in that it is propelled along tram lines in front of, and parallel to, the retorts, and consists of a frame on three wheels. The hand rake for drawing the charge is raised or lowered, to the retort required, by means of an adjustable bearer bar, parallel to the retorts, and guided by two of the frames of the drawing machine. With this manual machinery 45 retorts can be charged and drawn in as many minutes, without requiring half as much fatigue as ordinary hand labor would involve.

Horizontal Retorts Machine Charged and Drawn.—In the manufacture of gas it is necessary to bring the coal from the pit to the gas works, from there to the retorts in which it is placed, and, after being subjected to a high heat, taken out as coke and removed to the yard. With the improved methods this is accomplished by means of various types of machinery. The designs of the particular classes of conveying machinery required for the handling of all coal coming to the works and of all coke leaving the works, need to be somewhat varied to suit local requirements. There are several installations in vogue, and at a great number of gas works partial installations. Sometimes the coal is elevated and conveyed by means of band conveyors, at other times by means of tray and pan conveyors, and in still other cases the coal is brought to the works and deposited into self-tipping wagons which discharge into a coal breaker. From here, by means of a chain bucket conveyor, it is elevated and discharged into another self-tipping wagon or buggy, running on an elevated tram road which extends over the entire length of the coal sheds. When the buggy reaches the point for the proper trimming of the coal, it is automatically discharged and returned to the conveyor to be refilled. When the coal is brought by water instead of by rail, a chain bucket conveyor is sometimes used to remove it from the ship to the breaker, from which it is taken to the coal shed, as previously described.

The coal is delivered from the sheds to the retort house by means of an inclined chute discharging into a hopper. This hopper is worked in conjunction with a bucket elevator, which conveys the coal to buggies running on girders over the tops of the fixed hoppers in the retort house. The coal is then discharged into the fixed hoppers, which are arranged at the top along the entire length of the retort house, thus making them available for any one of the settings. From these hoppers it is fed into the adjustable coal hopper of the charging machine.

The power charging machines are operated by steam, compressed air or hydraulics, and fitted with propelling gear for travelling up and down in front of the retorts. They are of various kinds. Some have fixed hoppers, others adjustable hoppers, which, by means of gearing, are raised or lowered to suit the various tiers of retorts. The weight of coal in a charge is regulated by a feeder box, with which the hopper is provided.

A frame suspended from the hopper carries the charger, which is driven in and withdrawn from the retorts by a compressed air cylinder, rack and pinion chain drum, and chains. The scoop of the charger enters each retort twice, turning alternately in opposite directions, thus insuring the coal being deposited equally over the entire base of the retort. The hot coke is taken from the retort by drawing machines, which are fitted with traveling and hoisting gear, by means of which the rake bar frame can be raised and lowered to convey the rake bar and head to the several tiers of retorts. They are fitted with compressed air and controlling cylinders, rack and pinion chain drums for the various operations.

The motive force—*i. e.*, air, steam or water—is conveyed from the receiver, boiler or accumulator by means of suitable tubes and fittings to the hose drum, in connection with each charging and drawing machine. The hose, leading from the drums to the machines, is especially designed to convey the force used. The drum works automatically, and the hose is supported at frequent intervals to prevent unnecessary strain. Sometimes the power is conveyed by means of endless wire or cotton rope, the rope being overhead and driven by a gas or steam engine placed in an adjacent room.

The coal can be supplied to the charger and a full charge completed in the retort in 30 seconds; or 120 retorts may be charged per hour. This, in comparison with the old method, is a paramount saving of labor, as well as of gas; the latter saving being due to the short space of time the mouthpieces are open.

The coke is carried from the cellars of the retort house to the outside of the building on a conveyor, where a douche of water is made to play upon it as it drops. It is then raised, on an inclined conveyor, to the coke breaking machinery, which consists of a circular frame composed of perforated plates having different sized meshes, and placed at a suitable angle. Two railway wagons are placed underneath this screen, the small coke falling into one and the breeze into the other. A third wagon, placed under the lower end, receives the larger pieces of coke that have traversed the entire length of the screen. It will be observed that, except for labor in actuating machinery, no actual manual labor need be employed on the coal from the time it leaves the mines until, as coke, it leaves the gas works.

Inclined Retorts, Gravity Charged and Drawn.—This method of carbonizing coal has been attended with many experiments and failures; but at present numbers of installations are working successfully, and additional ones are being erected.

Inclined retorts are placed at an angle of 29° to 34° for the best working, varying according to the physical condition of the coal. The coal is delivered in various ways to the overhead hopper in the retort house by elevating and conveying machinery, similar to that previously described. Some of the recent installations do away with the trimming of the coal in the yard.

A measuring chamber is placed immediately beneath the coal hopper, and one above each vertical line of retorts. The weight of the charge can be adjusted as required. The same quantity of coal is charged each time into the retorts. Traveling chutes are provided for conveying the coal from the measuring chambers to the retorts. The charging is accomplished by simply drawing a lever, which allows the coal to fall from the measuring chamber down the chute and slope of the retort, the impact being regulated by a wing placed in the mouth of the chute.

Usually a little assistance is required to draw the coke, owing to caking and other reasons; but, after it is once disturbed, it quickly runs down the slope and discharges itself, by elevating and conveying machinery, in a similar manner to that described under "Horizontal Retorts, Machine Charged and Drawn."

It will be noted that the retorts are charged and drawn by means of gravity, which dispenses with charging and drawing machinery.

Very little is left to the discretion of the operator, and in the best installations none of the coal or coke is handled by manual labor, the only labor required being for the placing of the chute and drawing of the lever.

Combined Retorts and Carburetted Water Gas Plant.—Any one of the three systems previously described may be used in conjunction with carburetted water gas plant. The last system of manufacturing gas is greatly in vogue in America, and is also being quite favorably considered by European engineers. Many installations are working in England and several on the Continent at the present time.

Anthracite coal or a portion of the coke is taken from the yard and used in the generator of the water gas plant for making gas; or, better still, the hot coke from the retorts is immediately used in the generator. In one or two instances water gas generators have been placed in the same building and very close to the mouth of inclined retorts, a portion of the hot coke discharging directly into the generators. The remainder of the coke is handled by conveying machinery, as previously described.

Carburetted water gas apparatus possesses several advantages not found in the manufacture of coal gas, some of which are the high candle power gas that can be made and the small amount of labor required. The plant itself requires much less ground space, and usually, for the same capacity, a smaller expenditure of capital account.

At this point it may be interesting to compare the proportionate amount of gas that one man can make in the various systems, during a working day, including all labor upon the works. The figures can only be considered relatively, as the conditions of different works vary:

With horizontal retorts hand charged	17,000 cu. ft.
" manual charging and drawing machines	25,000 "
" power charging and drawing machines	30,000 "
" inclined retorts	35,000 "
" carburetted water gas	50,000 "

Condensers, Scrubbers and Washers.—Modern works also contain

improved apparatus and machinery for dealing with the gas after it leaves the retorts, but the condensing, scrubbing and washing machinery is only a perfection of the same system which has been in vogue for a number of years.

The cyanide compounds are next taken from the gas.

Exhausting Machinery.—The exhausters are usually placed between the condensers and scrubbers, and during recent years have been made so that the adjustable blades enable an exhauster of the same size as the old form to handle 50 per cent. more gas. The regulating machinery for exhausters has reached such a degree of perfection as to render the working of the machinery automatic, thus needing no attention from an attendant.

Purifiers.—The remaining gaseous impurities are finally removed by means of the purifiers. These usually consist of a series of large iron boxes with movable covers. When it is remembered that one purifier may contain as high as 75 or 100 tons of purifying material (such as hydrate of lime, which in itself has the properties of eliminating the whole of the impurities from the gas, or hydrated peroxide of iron, which will remove the sulphuretted hydrogen, but has no effect upon the carbonic acid and bi-sulphate of carbon) the importance of this apparatus in saving manual labor will be appreciated. In cold climates, found in certain parts of Europe and America, the purifiers are frequently placed in sets of 4, 6 or 8 upon the first floor of a building known as the purifying house. The covers are handled by means of machinery, frequently hydraulics, whereby one attendant can very readily raise a lid from a purifying box and replace it.

The purifying material is brought under the purifiers, in railway trucks running on the ground floor, within the purifying building. It is conveyed, by means of a chain bucket conveyor from the ground floor to the top of the purifying house, above the boxes, and discharged into a hopper, from which the material runs down a portable chute into any one of the purifiers, and at any particular point required. After the box has been properly filled, the cover is again placed in position and the gas turned on. When the material becomes foul, apertures in the bottom of the purifying boxes are opened, and the foul material is allowed to drop to the ground floor of the purifying house. If oxide of iron, it can be revivified and used over again for a certain period of time; if lime, which is not fit for further use, it can drop into railway wagons or carts and be taken away.

In other places the purifiers are placed on the ground level, continuous under a shed, which allows a free circulation of air. The lids are operated by machinery.

Sometimes a floor is placed directly over the purifiers, under the roof of the shed, and the oxide of iron for revivifying is elevated from the boxes to this floor, by means of conveyors. The fresh material is also conveyed to this floor from railway wagons, by means of conveying machinery, and the boxes filled by allowing the material to drop through apertures in the floor.

One or two works are doing away with the usual water seal and using comparatively small lids, with a rubber joint between the lid and the box, or a faced joint well greased with tallow. The lids are bolted down to ensure a tight joint.

Gas Holders and Governors.—Formerly a constant pressure of gas was maintained on the street mains by means of someone weighting the governor at the times of greatest consumption, but recently, in some works, a constant pressure is maintained to the consumers by means of a governor actuated by clockwork or electricity, so that if the pressure increases a valve at the outlet of the holder is partly closed, and if the pressure decreases the same valve is automatically opened, which still further reduces manual labor.

Residual Product Works.—Residual products were formerly sold in the crude state, but plant for the profitable manipulation of these on the gas works is now found. These are principally chemical and outside the range of this paper.

Although modern gas works have reached a degree of perfection second to no other manufacturing establishments, yet they have scarcely reached the point whereby the manager, in his office, can touch an electric button and manipulate the entire plant automatically. A number of men are still required on the works, and valued, not only for their physical strength, but for their intellectual ability, as everything is worked so nearly automatic and by machinery that the actual manual labor has been reduced to a minimum; and practically no heavy labor is now required in comparison with former days.

THE proprietors of the Chuctanunda Gas Light Company, of Amsterdam, N. Y., have agreed on an increase of capitalization, from $50,000 to $100,000.

Efficiency Test of a 125-Horse Power Gas Engine.

At the New York meeting of the American Society of Mechanical Engineers, Mr. C. H. Robertson of Lafayette, Ind., presented a paper giving the results of tests at various loads of a 125-horse power Westinghouse gas engine, which is located in the plant of the Merchants' Electric Lighting Company of Lafayette. The plant, which is a new one, was constructed in 1898, and is substantially as show in Fig. 1, a plan of the station.

There are two 125 horse power gas engines in the engine room using natural gas as fuel, and each driving a 60 kilowatt two-phase alternator of 2,000 volts at 60 cycles. This type of Westinghouse gas engine was fully described and illustrated in "The Engineering Record" of October 21, 1899. The engine tested had three cylinders, each 13 inches in diameter and 14 inches stroke. The clearance of each was about 21½ per cent.

The cylinder walls are kept cool by the use of water jackets; the plant is so piped that city water may be used, but ordinarily a small belt-driven pump takes water from a cistern below the repair room floor, and, after passing it through the jackets, delivers it to the top of a cooling tower, whence it trickles down over piled tiling to the cistern. In passing down through the tower it is met by an ascending stream of air, by which it is cooled. No mechanical means are used for inducing the flow of air, the warming of it sufficing to produce the draft.

The test was made under the personal direction of the author, and during its progress the entire load of the station was thrown upon one engine, the load being the ordinary service load on one of the light days of the week. The time and duration of the test, 7:05 P.M., March 22, to 12:05 A M, March 23, 1899, was chosen so as to include a considerable load variation in order that the performance under different conditions might be observed. The object of the test was to secure reliable data concerning the power developed, the gas consumed, the speed regulation, the heat given to the jackets and the temperature of the exhaust.

A Crosby indicator was attached to each cylinder, one being of a special construction for gas engine work; the others, steam engine indicators. The springs were changed from time to time to adapt them to changes of pressure due to changing of the load. No difficulty was experienced from the heating or lack of lubrication of indicators. It was not even necessary to lubricate the indicator pistons, plenty of cylinder oil for this purpose coming up from the cylinders of the engine.

The indicator rig consisted of a small set of three cranks turned from a solid piece of steel and attached by means of a cap to the end of the engine shaft. Connecting rods and crossheads with steel wires and short pieces of indicator cord served to transmit the motion over light brass pulleys from each crank to its corresponding indicator. The electrical output was determined by experienced men with freshly calibrated apparatus. The gas consumed was measured by a wet meter, and corrections were made for variations from standard pressure and temperature.

The amount of heat absorbed by the jacket was determined by measuring the rise in temperature and the weight of water passing the jacket. The results are given in Table I.

TABLE I.

No. of hour.	B. T. U. supplied, per hour.	B. T. U. converted into work, per cent.	B. T. U. absorbed by jacket, per cent.	B. T. U. exhausted per hour, per cent.	B. T. U. per I. H. P. per minute.
1	1,574,200	17 8	25.1	56.9	237.5
2	1,674,880	16.3	21.0	62.8	264.7
3	1,169,000	20.7	30.2	48.8	204.2
4	1,096,600	20.2	36 9	42.7	211.1
5	828,000	16.0	50.3	43.9	259.3

The temperature of the exhaust gases was determined by a copper ball calorimeter. This consisted of an arrangement which permitted of placing the copper ball at the bottom of a thin cup-shaped pipe which projected into and a little past the center of the exhaust pipe near the engine. After it had been in this position about an hour, the ball was withdrawn and dropped into a non-conducting cup containing a measured quantity of water. From the specific heat and weight of the copper ball, its initial temperature was found. The temperature of the exhaust by this method was found to be 1,200° Fahrenheit when the engine was indicating 104-horse power, and about 1,048° when indicating about 55-horse power.

The natural gas which is used as fuel was analyzed with the following result:

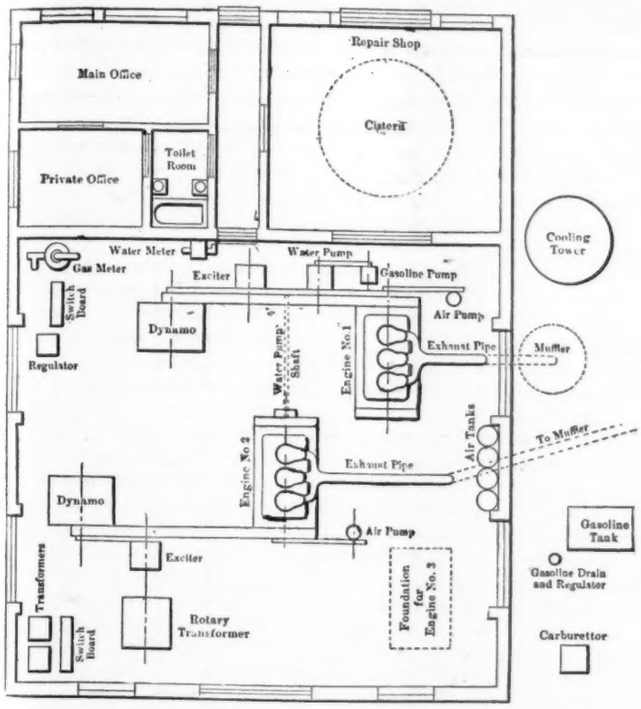

Fig. 1.—Plan of the Lighting Station.

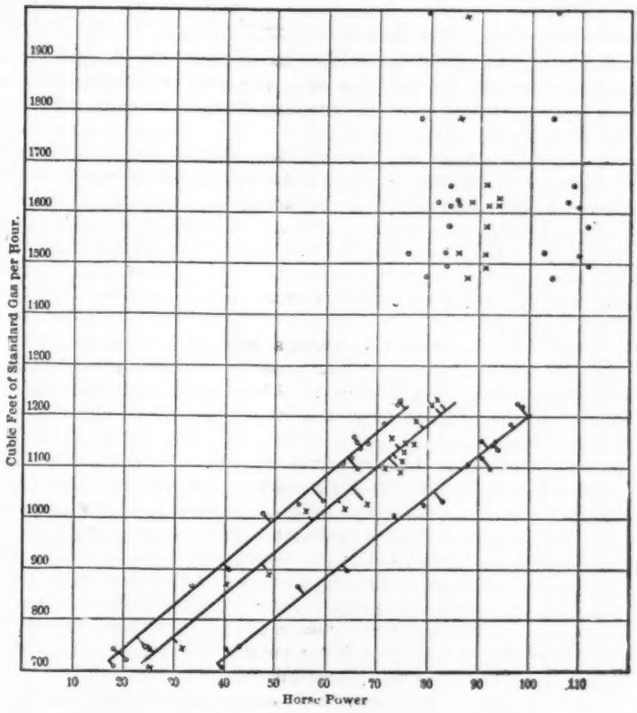

Fig. 2.—Relation Between Power and Total Gas per Hour.

Merchants Electric Lighting Plant, Lafayette, Indiana.

Carbon dioxide (and H_2S)	1.80	per cent.
Oxygen	0.70	" "
Hydrocarbon	0.50	" "
Carbon monoxide	0.55	" "
Hydrogen	0.60	" "
Methane	92.05	" "
Nitrogen	3.80	" "
	100.00	

The plant was not put in especially good condition for the test, and there was no attempt on the part of the writer to secure better economy by changing the conditions from those ordinarily observed by the attendant, the desire being to secure data under ordinary service conditions. From the beginning of the test, 7.05 to 9.15, the mixing valve was set so as to give a mixture of gas to air of 1:11. At this time the ratio was changed to 1:12, remaining thus to the end of the test.

In Table II is given part of the data and calculated results given by the author. In column 3 is shown the gas used for each ten minutes reduced to a common basis of 14.7 pounds pressure and a temperature of 62° Fahrenheit. The whole sequence of events, from the gas meter to the engine and generator in a plant like this, follow each other so rapidly, the author said, that it is entirely possible to run a satisfactory and reliable test of but a few minutes' duration. With this point in mind, the whole collection of data, consisting of 5 hours of 5-minute observations, was divided up into a series of tests of 10-minutes' duration, in each of which an observation was had at the beginning, in the middle, and at the end of the 10 minute period under consideration. The gas consumption for any one of the 10-minute tests was, of course,

TABLE II.

Time.	Revolutions per Minute.	Standard Gas per Ten Minutes.	Average Indicated Horse Power.	Total Output Electric H. P.	Total Input or Brake H. P. of Engine.	Frictional Horse Power of Engine.	Mechanical Efficiency of Engine, per Cent.	Standard Gas per I.H.P. Hour.	Standerd Gas per Brake H.P. Hour.	Standard Gas per Electric H.P. Hour.	Mechanical Efficiency of Plant — Col. 5 ÷ Col. 4.	Thermal Efficiency of Engine.	Thermal Efficiency of Plant.
1	2	3	4	5	6	7	8	9	10	11	12	13	14
7:10 P.M.	269	253.2	109.79	83.05	90.74	19.05	82.07	13.84	16.74	18.29	75.88	15.20	13.9
7:20 "	269	249.2	111.55	83 70	91.40	20.15	81.93	13.40	16.36	17.86	75.03	15.55	14.1
7:30 "	270	242 5	111.10	83.95	91.50	19.60	82.36	14.18	17.22	18.03	75.61	14 78	13.5
7:40 "	269	269 7	.....	86.05	93.50	.....	.....	.....	17.31	18.81	.....	14.70	13.5
7:50 "	265	270.7	.....	85.80	93.35	.....	.....	.....	17.41	18.93	.....	14.62	13.4
8:00 "	272	268.7	109.43	84.40	92.00	17.43	84.07	14.73	17.52	19.10	77.13	14.51	13.3
8:10 "	267	275.6	108.37	84.15	91 70	16.67	84.62	15.26	18.04	19 65	77.67	14.11	12.9
8:20 "	273	270.0	107.39	81.90	89.60	18.79	82.50	15.08	18.28	19.78	76.26	14.07	12.8
8:30 "	271	245.5	104.53	79.75	87.65	16.88	83.85	14.09	16.81	18.47	76.29	15.11	13.7
8:40 "	276	332.6	105.26	79.45	87.30	17.96	82.94	18.97	22 86	25 42	75.48	11.12	10.1
8:50 "	268	297.6	104.47	78.50	86.40	18.07	82.70	17.09	20.66	22.74	75.14	12.31	11.2
9:00 "	269	253.4	102 66	76.05	84.05	18.61	81.87	14.71	17.66	19.99	74.08	14 06	12.7
9:10 "	269	204.6	97.85	74 40	82.40	15.45	84.21	12.55	14 90	16.50	76.04	17.00	15.4
9:20 "	269	203.4	98.88	74.05	81.25	17.63	82.17	12.34	15 02	16.35	74 89	16.84	15.4
9:30 "	270	197.6	96.50	74.35	78.50	18.00	81.35	12 28	15.10	16.61	73.94	16.81	15.3
9:40 "	271	191.4	93.40	68.25	76.20	17.00	81.80	12.29	15.03	16.82	73.07	16.88	15 1
9:50 "	272	189.4	93.01	66.70	74.85	18.16	80.47	12.21	15.18	17.03	71.71	16.76	14.9
10:00 "	271	182.6	92.27	66.30	74.50	17.77	80.74	11.87	14.71	16.52	71.85	17.30	15.3
10:10 "	270	190.4	91.90	65 90	74.10	16.80	81.72	12.43	15.21	17.33	71.71	16.50	14.6
10:20 "	271	186.4	90.90	65.10	73.40	15 50	81.85	12.30	15 03	17.17	71.62	16.70	14 8
10:30 "	272	191.8	90.75	65.10	73.40	17.35	80 88	12.68	15 67	17.67	71.74	16.23	14 3
10:40 "	273	184.6	88.24	63.35	71 55	16.66	81.11	12.55	15.48	17.48	71.82	16.44	14.5
10:50 "	270	172.2	83.05	59 55	67.90	15.15	82.75	12.44	15.21	17.35	71.70	16 77	14.6
11:00 "	274	171.2	79.31	54 95	63.30	16.01	79.81	12.94	16.23	18.69	69.29	15.68	13.6
11:10 "	274	168.0	73.52	48 55	56.50	17.02	76.85	13 71	17.84	20.76	66.03	14.26	12.2
11:20 "	280	149.4	64.20	40.90	48.80	15.40	76.01	13.96	18.37	21.91	63.71	13.92	11.6
11:30 "	276	144.4	54.69	33 60	41.10	13 59	75.15	15 84	21.08	25.78	61.44	12 07	9.9
11:40 "	270	124.8	43.08	24.30	31.20	11 88	72.42	17.38	21.00	30.81	56.41	10.60	8.2
11:50 "	270	123.8	40.31	18.30	25.05	15.26	62.14	18.42	20.65	40.59	45.40	8.58	6.2
12:00 "	271	117.6	39.75	18.10	24.80	14.95	62.39	17.75	28.44	38.98	45.56	8.94	6.5
Average	270.86	211.42	88.79	65.51	73.266	16.88	79.74	14.18	17.964	20.704	70.23	14.613	12.92

taken as shown by the gas meter for that period. The results in the remaining columns are given in this averaged way.

In column 5 is given the generator output in electrical horse power. From a previous investigation the commercial efficiency of the generator under various loads was known, which, divided into column 5, results in column 6, the power given to the generator pulley. This, neglecting under the circumstance, the small belt losses, is the brake horse power of the engine. The brake horse power subtracted from the indicated horse power gives the friction of the engine. The brake horse power divided by the indicated horse power gives the mechanical efficiency, of which the highest, 84 62 per cent., occurred at 8.10, or at the time not far from the maximum indicated horse power. This is proba bly a little lower than it would be for a steam engine of the same general type and size. The frictional horse power as an absolute quantity decreased with the decrease of indicated horse power, but relative to the indicated horse power, became larger and larger as the load went down. This is, of course, but another way of saying that the mechanical efficiency decreases with a decrease of indicated horse power.

Columns 9, 10 and 11 show the gas consumption per indicated horse power hour, per brake horse power hour and per electrical horse power hour. The best performance of the plant in regard to these three factors occurs at 10.00, and is per indicated horse power hour, 11.87; per brake horse power hour, 14.71; per electrical horse power hour, 16.52 The highest consumption, under a mixture of 1:12, comes at 11.50, and is per indicated horse power hour, 18.42; per brake horse power hour, 29.65; per electrical horse power hour, 40.59. By plotting the total gas per hour against the different horse powers, Fig. 2, a very interesting law seems apparent. It is nothing more or less than the parallel of the well known Willans law for steam engines, namely, that the total steam per hour plotted against the indicated horse power is a straight line.

Referring to Fig. 2, the solid circles show the relation between total gas per hour and the indicated horse power. The points up to 100 horse power fall within a reasonable distance of the straight line drawn to represent their average. The crosses represent the same relation for the brake horse power, while the hollow circles are the points for the gas per hour against electrical horse power; and the same general ob servation may be made for these as for the indicated horse power line Three quite important conclusions seem to be warranted by this comparison:

1. That the proportion of gas to air is a very important factor in fuel economy.

2. That one test at a light and one test at a heavy load would serve to locate the line, from which a quite approximate prediction could be made of the gas consumption under intermediate loads.

3. That these considerations hold for the fuel consumption per brake horse power hour and per electrical horse power hour.

By Fig. 3 is shown the relation between standard gas per indicated horse power hour and the indicated horse power based upon observa tions when the mixture was 1:12. The other curves on this figure show gas consumption per brake horse power hour and per electrical horse p)wer hour.

In column 12 is the efficiency of the mechanism of the plant, found by dividing the output of the generator by the power furnished in the engine cylinder; in other words, the electrical horse power divided by the indicated horse power. Column 13 shows the thermal efficiency of the engine, and is found by dividing the number of British thermal units equivalent to the brake horse power by the number of heat units in the gas consumed. The highest efficiency, 17.3 per cent., is seldom equaled in a steam plant; but it is not high for a gas engine. Column 14 exhibits what may be styled the thermal efficiency of the plant. It is the result of dividing the heat energy of the electrical output by the heat energy in the gas consumed in its production, and gives as a maximum value 15.4 per cent.

Table I. accounts in a general way for the best transformation in the engine. The figures are based upon the averages for each hour during the test. The poor showing for the first and second hours was due to the improper ratio in the mixture of gas and air. For the third hour it is to be observed that about one-fifth of the heat energy of the fuel reappeared as work in the cylinder, that about three tenths was absorbed by the jacket, and that one-half passed out through the exhaust. The item British thermal units per indicated horse power per minute for the hour is seen to be 204.2, and is of interest for purpose of com parison. The best performance of the test in this regard is at 10, when the gas per indicated horse power per hour was 11.87 cubic feet, giving for the British thermal unit per indicated horse power per minute, 197.8.

The author concluded his paper with some miscellaneous notes, which were as follows: It should be borne in mind in considering the data here presented that the engine tested was of a lot of five engines, and was put in a short time after its mate, which was the first of this make and size installed for commercial service in this country. Since they

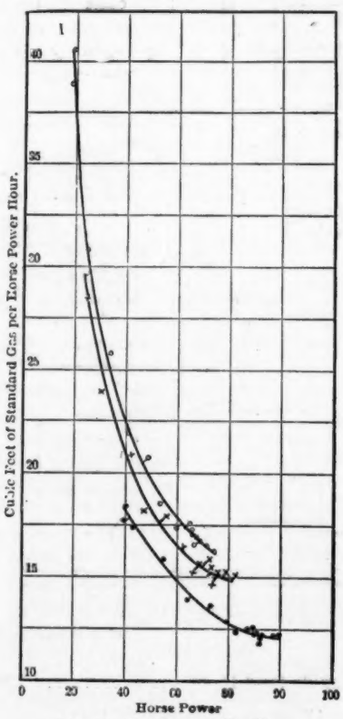

Fig. 3.—Gas Consumption Curve.

were installed, gas enginery has made a considerable advance, and the performance of this machine is probably not as good as an up-to-date engine would give.

Chief among the changes expected to give greater economy will be the substitution of solid oil in the crank case instead of oil and water as at present. It is stated on good authority that the presence of water in the oil, when exposed to the conditions met with in the cylinder, very much injures its lubricating effect, whence comes rapid wear of cylinders and bearings, and, consequently, low mechanical efficiency. Care must be exercised in the amount of oil permitted in the crank case, lest so much reach the cylinders as to carry flame over an exhaust stroke and ignite the next succeeding charge, and with it the mixture in the distribution pipe. Any considerable amount of this "back firing" has a very detrimental effect on the engine in general, and seriously interferes with good governing. Back firing may also be caused by a leaky admission valve or a leak in the caging on which the admission valve is seated. Cases have been reported where engines are running on gasoline in which a coating of burnt oil has collected on the end of the piston. This, it is thought, may come to a high enough temperature to ignite the incoming charge. At any rate, the back firing ceased with its removal.

The red glow of the exhaust pipe at night, or the red hot condition of the copper ball used in determining the exhaust temperature, bore convincing evidence of the high temperature within the cylinder. This high temperature gives some trouble with the exhaust valves, making it necessary to watch them quite closely lest a little leak soon burn out into a hole of considerable dimension. This intense heat sometimes has caused the breaking off of the exhaust valve stem. The use of more metal in the valves has practically ended these troubles. In a gas engine plant the certainty of action depends upon a number of details such as quality and time of ignition, proper compression, right proportion of gas to air, control of cylinder temperatures, etc. On one occasion sand was deposited in the jacket from the cooling water, making it impossible to cool the cylinder properly. The result was that the heat of compression furnished a high enough temperature to ignite the charge, and the engine was run for some time without the igniters in operation. At various times the gas supply for the city has been shut off. Under such circumstances the engine, acting as a pump, has continued to draw gas from the mains, and to run through such shut offs of 30 minutes' duration.

Soon after the gasoline vapor generator was installed, artificial gas was piped to the plant, and proved so much more convenient for emergency runs that the vapor generator was not used, and at the present writing has been removed. In the warm months of summer trouble has been experienced in cooling the jacket water in the cooling tower. As a result, a motor and pump were installed at the river bank, some distance away, and the jacket water secured from that source. As soon as the warm months are over the cooling tower is used again. Natural gas is sold to the company by meter at the rate of 7 cents per 1,000 cubic feet.

Texas Petroleum.

By Mr. F. C. Thiele, in *Am. Chem. Jour.*

It has long been known that mineral oil existed in the State of Texas, but only of late has this discovery been utilized. About three years ago oil was discovered in the town of Corsicana, and further researches proved that Corsicana was literally built on a vast oil pool. About 400 wells are in operation at present. A big refinery was built to dispose of the natural product, and Corsicana is a flourishing town to-day. All this was accomplished in the short space of a couple of years through an accidental discovery.

The Corsicana oil, as it comes from the wells, resembles in its appearance the Lima-Ohio oil, without having, however, the disagreeable odor, so characteristic of the oil found in the Ohio-Indiana district. An analysis made by the author shows the Corsicana oil to be composed as follows:

Crude Oil—Specific Gravity = 0.8296.

	Per Cent.	Specific Gravity.
Naphtha	10.8	0.710
Kerosene	54·5	0.796
Residue	34.7	0.905
	100.0	

A more elaborate analysis made by Mr. E. H. Ernshaw shows the following composition of the Corsicana oil.

Oil very dark-brown and opaque, but thin and fluid at 60° F. Specific gravity at 60° F. = 0.8292.

Temp. Deg. F.	Percentage by Volume.	Percentage by Weight.	Specific Gravity at 60° F.	Color, Etc.
A.....130–200	2.80	2.24	0.6653	
B.....200–250	5.10	4.31	0.7017	
C.....250–300	7.60	6.69	0.7302	
D.....300–350	8 20	7.44	0.7527	Colorless.
E.....350–400	9.40	8.75	0.7718	
F.....400–450	7 40	7 07	0 7920	
G.....450–500	8.30	8 09	0 8088	
H.....500–550	6 45	6 43	0 8260	Very faint yellow.
I.....550–600	7 75	7 85	0 8404	" " "
J 600–650	14 95	15 43	0.8555	Yellow.
K 650–655	17.25	18 07	0 8687	Deep reddish-yellow.
L... over 650	1.30	1.41	0 8972	Deep red—solid.
M....over 550	1.40	1 63	0.9699	Dark red-brown—sold.
Residue	....	2.63	....	
Total	97.90	98.04		

The above analysis shows the Corsicana oil to be closely related to Pennsylvania oil, especially that of the Washington district, but it contains, according to my researches, a certain amount of asphaltum or bodies very similar to it. The presence of asphaltum compounds in crude oils can easily be demonstrated by the addition of tin tetrachloride, $SnCl_4$, to a sample of the oil in question. If a black precipitate is formed on the addition of the reagent, asphaltum or similar compounds are present in the oil. I found this reaction to be of value for oils which are subjected to distillation, as oils containing asphaltum should be distilled with great care and a very gradual rise of temperature, so as not to get too large an amount of the terpene-like decomposition products of the asphaltum in the distillates. The presence of these bodies, which resemble aromatic hydrocarbons, tend to color the oil yellow, and even a very effective acid treatment does not seem to improve the oil much in color. This behavior of the distillates resembles the one which oils show when they have been subjected to overheating, as in the case of certain desulphurizing processes, proposed for the purification of strongly sulphur bearing oils, such as Lima, Canadian and others.

It was soon found, after the Corsicana oil field was discovered, that oil existed in other places in Texas, and borings for it were rapidly made in a number of places. It soon developed that a well defined oil stratum existed, which, following the Trinity river to Nacogdoches, and turning here and following the Sabine river, flowed out into the Gulf of Mexico at Sabine Pass, covering the water at times with a black greasy substance over quite a large area.

The oil found at Nacogdoches is very heavy, its specific gravity being 0.915. Its color is black, and it is strongly impregnated with sulphuretted hydrogen. It occurs in shallow wells not over 90 feet deep, and very likely belongs to the class of oils which are described in the literature as maltha.

From Nacogdoches, going south, the oil makes its next appearance at Rockland, the terminus of the Rockland, Sabine Pass Railroad. It is asserted that the oil exists here in large quantities, but no researches regarding its properties have been made. Saratoga, south of Rockland, is the next place where oil deposits are found, and experimental boring has been going on here for some time. The oil found here is still heavier than the Nacogdoches oil, having a specific gravity of 0.955. It is a black oil rich in asphaltum.

Fourteen miles south of Saratoga is the watering place of Sour Lake, where a large oil deposit occurs. The soil at Sour Lake is undoubtedly of volcanic character, judging by the large variety of waters found here, and the general condition of the territory.

The crude petroleum found at Sour Lake occurs at a depth of 250 feet in the alluvial formation, and is what is termed a "surface oil." Its specific gravity at 63 5° F. is 0.963, which is the highest specific gravity observed with any crude oil found in the western hemisphere. A fractional distillation of the oil shows the following constituents:

Fraction.	Temperature, Deg. F.	Percentage by Volume.	Specific Gravity.	Color, Etc.
1.....	....	....	....	
2.....	212–266	0.07	....	Yellow.
3	266–320	0.03	....	"
4.....	320–392	1.59	0.684	"
5.....	392–572	19.49	0 840	" blue fluorescence.
6.....	....	....	....	
7.....	572–641	5.15	0.782	Dark yellow.
Residue		71.11	0.978	Black.
Total		97.44		

The oil contained 20 per cent. asphaltum.

The analysis was carried out according to the directions laid down by R. Kissling during his investigations of crude oils of different origin.

The above analysis indicates that the greater part of the oil is composed of hydrocarbons excellently suited for lubricating purposes, and the last fraction has a viscosity of 19° (Engler apparatus), a figure which exceeds that of the heaviest Russian products. Tests which were made on the large scale showed the presence of aromatic hydrocarbons, such as pseudocumene and others, and according to its behavior the crude oil may be called a true representative on American soil, of the oil found at Wietze-Steinförde, Germany, which was pronounced by Prof. Engler one of the most valuable sources of high grade lubricating oils, if it could be freed of its asphaltum by proper refining and treatment. Solid paraffine has not been found in the crude oil, nor in any of the refined products, and it is doubtful whether any is present.

As to the origin of the oil, the presence of aromatic hydrocarbons and the absence of solid paraffine would indicate a vegetable origin, but, on the other hand, nitrogen products and a large amount of sulphur have been found in the oil, and these facts favor the view that it is of animal origin.

I cite here a test which I made to further advance the knowledge of this interesting oil. Some of the oil was dissolved in benzene, C_6H_6, which dissolved it with the separation of some water. The latter was removed and alcohol of 85 per cent. added until no further precipitation occurred. The whole was well shaken, and after standing for some time the supernatant clear liquid was removed from the black resinous mass formed on the bottom of the vessel. The clear liquid was evaporated on a water bath at a temperature of 80° C. A very viscous oil remained behind, which, when heated to 120° C., gave a very decided odor of musk.

The black resinous mass, dried at 120° C. for several hours, presented, after cooling, the general properties of "goudron," but had an odor which could not be distinguished from rancid stearin. This distinguishing feature recalls some experiments which were published in the "Chemiker Zeitung" several years ago on the distillation of so called "stearin pitch." Products were obtained which resembled in every respect the distillates obtained from mineral oils. As stearin is undoubtedly of animal origin, the above discovery may furnish further evidence of the correctness of the theory of Höfer and Engler.

It has often been asserted that the water which comes up with the crude oil when the latter is pumped out of the well does not contain

any sulphates or merely traces of them. C. Ochsenius especially expressed this opinion very strongly and tried to prove that such was the case in every instance. The conditions are, however, different in Sour Lake. As I have stated already the character of the territory there is undoubtedly volcanic, and numerous water wells occur there which are very strong in sulphates, especially alumina, and contain in many instances large amounts of free sulphuric acid. The water coming out of the ground carries with it considerable oil, which floats on it as a thick black tar. The oil wells which were sunk artificially contain water, which is strong in chloride of sodium, but still contains a considerable amount of sulphates. Whether the occurrence of this large amount of sulphates and free sulphuric acid is related to the genesis of the oil or not is an open question, but as the opinions are still divided on this subject I deemed it necessary to mention the facts as they are presented by nature.

[From *Engineering*.—Continued from page 971.]

American Competition.—No. XII.

By Mr. Robert S. Ball, Jr, B Sc., London.

The observer who has come into close contact with engineering work in England and in the United States, cannot fail to receive certain impressions which suggest reasons for the increasing success of American manufactures in competition with England at home and abroad. He notices in America many strong influences and economic tendencies directed towards increased commercial enterprise, the results of which, seen on this side of the Atlantic, give rise to fears for our future industrial welfare. He sees Englishmen, and men of other nationalities, working side by side with the native in American works, whose time measured in dollars and cents is not less valuable, and the quality and quantity of whose work is at least equal to that of their Transatlantic cousins. Moreover, he would notice that the Englishman is quite on a par with the American in originality and inventive genius, and even if the list of the world's great inventors did not indubitably prove that the Britisher was not lacking in ingenuity, he would be convinced by his experience that the Englishman in America can hold his own with the native born American in this respect.

To explain, therefore, what has been termed Yankee ingenuity and the acknowledged superiority of many kinds of American manufactured articles, we must seek for the reasons among conditions incident to the development of a comparatively new country combined with a social and political environment wholly different from our own. Though there are other parts of the world possessed with an equal store of bounteous natural wealth, and a bracing climate similar to that of the northern States of North America, it is correct to say that the United States stands prominently forward in the extraordinary development of the mechanic arts and sciences. We are thus forced to look for the causes of this material development among social institutions, which do not exist in countries equally favored by nature, and which contribute in a large measure to the utilization of the natural wealth of any country.

However exaggerated the idea of American liberty may be, it is undoubtly true that the American workman enjoys a large measure of independence of a kind conducive to the development of his intellectual capacities. This independence, or, perhaps, it would be more correct to say, freedom from restraints prejudicial to his advancement, enables each man in an engineering works to utilize his own powers and opportunities to better his position with his employer, and to earn wages proportionate to the worth of his work. He is independent of his fellow workers in the sense that he is free from the damaging effects of trade union oppression, his value is not gauged by that of his fellow union workers, nor are any restrictions placed upon his output for the object of keeping him down to the level of the average. Though American trade unions are highly organized, and powerful, fraternities which jealously guard the workman's rights, and sometimes do not stop short of riot and bloodshed when their just or unjust demands are not granted, their effect is less insidious than continued interference with the liberties of the workman by limitations put upon his earning capacity. There is, however, no intention here to magnify the effect of existing differences between English and American trade unions for the purpose of explaining the social status of the American workman; it has something to do with the conditions under which he works, but is not alone accountable for that independent spirit which marks the employee of American engineering works.

The great flexibity and rapid changes continually taking place in the management of American engineering works, inspire hopes in the workman that by close attention to his work he may become foreman, superintendent, or manager in the near future, and ultimately acquire a share in the business. It is not uncommon to find men who have thus made their way rapidly, and the opportunities for so doing are greater in America than in England. The conditions which most favor such rapid advancement are better seen in the Western States, where emigrant mechanics quickly establish themselves in positions only reached by a few at the end of a lifetime in Europe. The effect of these many chances thrown open to every man is seen by the intense energy and interest which the American workman puts into his work. He applies his inventive capacity vigorously in the hopes that by some successful patent he may be able to obtain the means to start himself on a career of his own; sometimes he stumbles upon an invention while endeavoring to find a method for turning out more rapidly the work upon which he is engaged—he works his mind as well as his hands to the benefit of his employer and himself.

Though inventors are encouraged in England by the protection of equally good patent laws, the English public are slow to take up new devices which appear to be in the experimental stage. As an instance of this, the American invention of an automatic cash system for use in retail shops, consisting of wooden balls running upon rails above the counters, was easily introduced in America as an obviously beneficial labor saving device. Bad luck attended the efforts of the inventor to establish it in England at first, and it is said that the manager of a large firm who was approached declared that he would not have his business done by croquet balls. When others were persuaded to give the system a trial, he was convinced that it saved both time and money by the release of a large army of cash boys.

Inventions which do not appear to possess the elements of success have a better chance of overcoming popular prejudice in America than in England. There are many inventions requiring no discernment to place them at once amongst those which would yield a good return. Of such might be mentioned the little boring bit, which bores the hole and countersinks for the screw head in the same operation, and which would sell every where. The encouragement which inventors receive in America, and the chances, however remote that they be, to become rich by a lucky hit, has the effect of making men keenly alive to any improvement which would enhance the sale of an article. Of the many patents allowed, comparatively few may be called successful; and it is such that are seen on this side of the Atlantic, which give to us the impression that the Americans are successful inventors, though the numberless failures, if known, would change somewhat our ideas upon that point.

It goes without saying that in these days of sharp competition, systematic methods in shop management are necessary in order to keep well in the race, and Americans are not slow to utilize every chance to increase the efficiency of their plant by the adoption of new devices or machines which would improve their shop system, or accelerate and cheapen the work done. A Kentucky manufacturer of fine woodwork was much struck, on a recent visit to England, by the difference between the shops and machinery equipment for this kind of work here and in his own country. On being asked the reason for his success in foreign markets in competition with England, in spite of the freight rates to Europe, he gave as his reasons the cheapness of hard wood at his works, but more important than that, the policy he had adopted of continued replacement of machines in his works by those of a better type. He was always willing to give a trial to any new machine which possessed, in his judgment, any better points than the one in his works. He sometimes made mistakes, but the success of others, combined with the knowledge that he had the best the market could afford, kept him in the forefront of the industry. There is no intention to draw invidious comparisons between systems of shop management in England and the United States. The Americans have by no means all that is best upon their side, as some would have us believe, and we could point to several examples of well regulated engineering works in England, from which the Americans might learn much of value. Looking at the question in the most impartial manner possible, there appears to be a more general display of systematic methods in American establishments, not alone confined to engineering, for the love of system seems to be a national characteristic of Americans. The stranger cannot fail to notice in the United States everywhere, this tendency to reduce everything to a cut and dried basis in political, commercial, and social affairs alike. The utilitarian side is always kept well to the front, and other considerations, which elsewhere would exert their influences, are sacrificed on the altar of utility.

A great deal might be said about a high degree of standardization in engineering works. When carried to the extent displayed in some of the works in America, it leads to the best engineering by reducing the

cost of production, if we can accept the definition of an engineer as being a man who can do for a cent what any fool can do for a dollar. The now familiar case of the Atbara Bridge is a glaring instance of the success which attends an almost perfect system of standardization and workshop management, without which the successful Philadelphia firm would not have been able to guarantee the prompt shipment of the bridge, a condition necessary in that case, and governing the placing of the order for that important structure. To describe the system in operation at the Pencoyd Iron Works, from the writer's personal experience, would be irrelevant to the present subject, but it is not wholly different from that in use in other works of a similar kind in the United States. The standardization of sizes and weights of rolled steel and iron shapes and sections is very beneficial to manufacturers and engineers, and the unanimity existing among steelmakers enables the engineer to obtain sections of the same size and weight at all the representative mills. This avoids the costly alternative of having special rolls cut, or of being bound to one mill for the supply of a certain shape. The American engineers have helped to promote this standardization by avoiding the use of special sizes as far as possible, and though it leads to rule of thumb methods in the profession, and makes the work of one man like that of another, it can be defended on the ground that it conduces to simplicity, which is not the least of the good qualities by which engineering work is judged. Also, the encouragement which the steel manufacturers give to a system of standardization, which is certainly beneficial to themselves, and which enables them to make close estimates on work, and to turn it out with the utmost rapidity and exactness, has made the work of the engineer easier by reducing the amount of toilsome calculation which otherwise he would have to do. He finds in the makers' catalogues such constants as moments of inertia, safe loads uniformly distributed, and many other useful tables to which he has to apply constantly. Though such tables are not wanting in some of the catalogues of English makers, they only refer to the sizes rolled by this or that manufacturer, and have no reference to a universal standard with which the American engineer becomes so familiar.

The astonishing rapidity with which structures are designed and erected in America is very largely due to these simplifications. The machines in a bridge shop, set to work at a special job, turn out day by day a quantity of work which would be impossible if the many different orders upon which they were engaged, included odd sizes of stock, or unusual manipulation. Take for example a multiple punch making the rivet holes in the cover plates for the top and bottom chords of plate girders. The shop is crowded with different orders which include plate girders of different sizes, and for various conditions of service. Though the rivet spacing for different sizes must necessarily vary, much time can be saved in the punching when odd rivet spacing, necessitating an awkward change in the feed of the punching machine, can be avoided. The prevailing practice in American bridge works is for the company to make their own designs, subject to the approval of the engineer for the purchasers; they are thus enabled to carry out a system perfect in the smallest details, and do not have to work from a variety of drawings possessing points of difference of detail supplied by other engineers.

As to the arrangement and equipment of American engineering workshops, many of them do not have much room for improvement in this direction. They are generally well lighted and ventilated, and the severity of the climate necessitates an elaborate heating system, as well as adequate arrangements for making them habitable during the hot summer months. While some of our workshops are not behind in this direction, more attention seems to be directed in America to hygienic considerations in working rooms and offices, the business offices in American cities being far superior to ours for comfort.

The great question of technical education and training has such a distinct influence upon engineering industries that it can hardly be omitted in dealing with the subject of international competition. We might divide the topic into three questions: (*a*) Are the facilities open to workmen for acquiring the rudiments of scientific and mechanical knowledge equally as good in England as America? (*b*) Do the workmen take advantage of such opportunities as are offered by the existence of free evening lectures and night schools? (*c*) What is the attitude of the employer towards technically educated men who have obtained degrees from technical schools or colleges of advanced standing?

The complete answer to the first of these questions rests with statistics which are not forthcoming at the present moment; but there seems to be no lack of opportunities in the manufacturing centers in England for men to spend their evenings listening to lectures upon scientific principles which they use unconsciously in their daily work, and which must be beneficial to them. To answer the second question, if we are to judge by the theoretical knowledge possessed by English and American workmen, we might infer that the latter made more use of his educational opportunities. He is, however, better situated to learn subjects which are incorrectly termed theoretical. He comes into close contact with numbers of young men fresh from the technical schools and colleges, from whom he cannot fail to get information which they are so ready to impart, and they likewise benefit by his years of experience. He has also, as Mr Barnes has pointed out, a better distribution of his working hours, which enables him to utilize his own time to better advantage.

The answer to the third of these questions has an importance which it is difficult to over-estimate, for the encouragement which technically educated men receive at the hands of American employers brings into the field of practical engineering a constantly increasing number of scientifically trained intellects, the effect of which is seen far and wide by the excellence of its results. The young technical college graduate, after taking his degree, finds employment waiting for him at one of the American engineering works. In nearly every case he receives pay for his services from the first day he enters the shop, which is increased as his experience adds value to his work. However small his remuneration may be at first, he is encouraged by the reflection that he is earning for himself, even though it may be only a fraction of his living expenditure. Without practical experience, but possessed with a training which enables him the more readily to grasp the details of shop practice, his employer sees in him a man whose value is likely to grow quickly as he gains shop experience. He has a slight acquaintance with the use of tools learned in the workshops at his college, which helps him in the more serious work he has begun. He remains in the shop long enough to become familiar with the processes carried on, though not to acquire a manual dexterity like that of an old hand, for he does not intend to stay at the lathe or bench. At the first opportunity he enters the drawing office, his pay is increased, and he begins to utilize his training to improve designs or make new ones.

In England the technical man is placed in different circumstances. After much time and money spent at college, he casts about for a chance to acquire practical experience, and is confronted with a very gloomy state of things. Eventually he succeeds in establishing himself in a works where, instead of being paid for his shop work, such as it is, he is obliged to pay for the so-called tuition. His time is utilized by the firm as the manager or superintendent may see fit, and he may be kept for months turning one size of bolt, which, unless he wishes to become a skilled lathe hand, is time wasted for him. His subsequent advancement may be due alone to the skill which he displays with tools, which does not seem to be the proper basis upon which to estimate the worth of a man whose education has been directed towards different work. This state of things, brought about solely by economic causes, and not by any tendency to discriminate against technically trained men, is none the less discouraging, and must prevent from taking up engineering in England many who would add much to the profession.

Unless we protect England and our colonies by a tariff, it is difficult to see how we can stem the tide of importation of American wares, and as for foreign trade we can only hope to continue to have a good share. To meet American manufacture by adopting American methods would be impossible, but we can always learn many useful things by watching the way in which our Transatlantic cousins make their successes, and we can also profit by their failures. It is very opportune that this question of American competition should receive close attention. However unpleasant it may be to know that our commercial supremacy has been assailed with some success, no good can come from shutting our eyes to facts.

The Appraisal of Water Powers.[1]

At the recent convention of the American Society of Mechanical Engineers a paper, entitled "On the Value of a Horse Power," was read by Mr. George I. Rockwood. Like a number of other contributions he has made to that Society, it aroused considerable discussion, and resulted in the passage of a resolution requesting the Council to consider the advisability of recommending a standard method of estimating the value of power in cases like the one in question. This was the suit of a number of mill owners against the city of Worcester for damages due to the appropriation by the city of Worcester of the waters of Kettle Brook. The appropriation was made in June, 1895. The brook has an average flow of about 5,500,000 gallons in 24 hours and discharges into

1. From *Engineering Record.*

the Blackstone river, passing the premises of 67 owners of 80 developed water privileges and a few not developed. The total head at all these privileges is 827 feet. The city officials and mill owners could not agree on a fair compensation to be paid for the loss of water at these sites, and the owners brought suit for damages, partly for the loss of mill ponds and entire mill villages, but mainly for the loss of power occasioned to them by the diversion of the water from their mills into the city's reservoirs.

About 1,000-horse power for 11 months each year was perhaps the total quantity of power lost, according to the estimates of the hydraulic engineers of both sides. They were not in precise agreement as to the amount, partly because they could not agree on the area of the watershed, and partly because of a difficulty in proving the actual rainfall on this watershed, and because of the possibility (to the legal mind, at any rate) that a given water power, improved by the regulating effect of certain mill ponds situated above it, was not legally worth any more on that account than it would be if they were not in existence, if the owner of the power privilege was not also an owner of the said mill ponds. The largest loss of power at any one privilege was about 66-horse power, and the smallest loss was a fraction of 1-horse power.

The cases were tried before three judges as a board of arbitration. One was a lawyer experienced in water cases, another a manufacturer and large user of water power, and the third a hydraulic engineer. The trial lasted some 50 days. Each side employed about a dozen eminent mechanical and civil engineers to give expert testimony as to the facts relating to the amount of water taken and power lost, and, particularly, as to the value of a horse power. The commission has given its opinion, and on June 28, 1899, a settlement was effected between the city and the petitioners amounting to $500,000, with interest for four years at 6 per cent. per annum. The exact sum was $615,259.

The occasion for the paper is found in the fact that it was possible, even at this day, for the counsel for each party to the trial to take diametrically opposite views of the true way to estimate the value of the power lost by the diversion. The two theories cannot be reconciled; yet each was advanced with entire confidence and unanimity. Throughout the taking of testimony, the delivery of arguments, and, as far as one can see, in the decision itself, both parties succeeded in maintaining their original positions, and, doubtless, were sincere in doing so.

The reasoning of the petitioners, the mill owners, was substantially as follows:

1. A horse power is a commodity which may be considered as on the market, and hence as having a definite market value, known to those who deal in it.

2. The owner of each of the 80 privileges has lost forever by the act of the city a certain definite number of horse powers.

3. The financial injury done this owner, therefore, may be found by simply multiplying the market value of 1-horse power by the number taken from him.

The damage for the mere use of the water for power as assessed in this way by the witnesses for the petitioners amounted to $1,300,000 to $1,800,000. These sums were many times larger than the amount of money admitted to be just compensation by the witnesses for the defendant. In reply to the theory of the petitioners, they argued that the petitioners had not been deprived of any horse powers, and there is no such commodity known as a horse power. The thing which the owners had lost by the diversion of water was not even the ownership of the water itself, but simply an easement—namely, the right to have the water come down through their premises from above in order that they might make any reasonable use of it which should not appreciably diminish its flow to others below them. It was used largely, by each manufacturer, for generating power at a turbine. Counsel for the city argued that the way to estimate the value of this use of the water to each petitioner was, first, to ascertain the exact extent to which the water was available for power throughout the year at each privilege; and then to estimate the cost of substituting other practicable and economical means of generating power to the same extent and at each privilege. This computation should give at least the highest possible annual value to this use of the water, but, in certain cases, it might exceed the actual loss sustained by the petitioner. Such a case would arise, for instance, where the waterfall was situated in a locality so remote from transportation facilities as to make it difficult to find a purchaser of the privilege at any price, even if already developed.

The witnesses for the defence also claimed that, as none of the horse powers of which its owner was deprived by the act of the city could have been sold anywhere except at the particular place where the falling water could be used as it fell (the only right, they maintained, which the city interfered with) to generate power, therefore there can be no such thing as the market value of a horse power resulting from this use, equally applicable to each unit of power wherever generated on this river. A horse power, being a unit of activity, not taxed, intangible, could not be a piece of property; but it was a property of a piece of machinery.

A witness for a petitioner, Mr. William Kent, specifically stated that a horse power is property which may be sold and has an established market value, which value must be somewhere near its cost of production by steam, in a given locality like that of these 80 privileges. He did not say anything about easements. A man who loses 1-horse power from a 20-horse power fall was assumed to be damaged to just the same extent as he who loses 1 horse power from a 1,000-horse power fall, even if—as was true in the Blackstone River mills—the one needs a 20 horse engine, with slide valve and throttling governor, to balance the inequalities of his 20 horse water power, while the other uses a 1,000-horse power engine to balance the inequalities of his water power. Moreover, the variation in the cost of coal up and down the stream is also immaterial on this basis, although it was as high as $4.60 at the source and as low as $3 at Pawtucket. These were the reflections of counsel for the defence. His own witnesses testified, one after the other, that the financial injury done the petitioners was certainly not greater than a sum of money the interest of which would enable them to produce the lost power by other means; that every mill owner operated a steam plant large enough, or nearly large enough, to carry the entire mill load; and that what these mill owners would do in future, as, in fact, they had done since the diversion, would be to carry the load, formerly driven most of the time by the lost water, continuously on their steam engines. Hence a coal pile large enough to do this, if freely supplied to them, would place them in as favorable a position to carry on business as they ever enjoyed. Some said they should, further, be allowed supplies, as waste, and oil, and labor. Still others thought they should, further, be allowed a part of the interest, depreciation, taxes and repairs on the steam plant; such a part of the whole amount of these items as the lost power bore to the entire power of the engine. One witness for the city thought that enough wasn't made of the benefit it would be to these engines, large and small, in the direction of smooth working, to carry continuously an additional load, thus allowing their valve gears to work more normally than before the diversion. He also called attention to the generally accepted belief that the friction of an engine was independent of the external load, so that, as it is friction that wears out an engine, no extra use of the mechanism was imposed on the mill owner as a result of driving the greater load. This witness favored compensation on a coal cost basis, in view of the fact that as (according to the testimony of the hydraulic engineer retained by the city) the flow of water was liable to almost entirely cease at certain times in extra dry years, therefore no one of these privileges was of any considerable value unless operated in conjunction with a steam plant of a size at least three-quarters of the greatest available power of the privilege. This was corroborated by the observed fact that in nearly every mill a steam power plant as large as, or larger than, this size, was at work all the year around. He testified, in effect, that the water privileges in New England which maintained a flow of water sufficient to drive a mill constantly all the year round could be counted on the fingers of a man's hands, and that none such could be found on either Kettle Brook or the Blackstone.

The attorney for the petitioners sought to have the city's witnesses admit the truth of Mr. Kent's theory, and say frankly that a water power was itself property; then that any sub-division of it, as 1-horse power, was also property. If he could do that then his side would win, for the "fair market value" shibboleth would become operative. Not the cost of making the power, but the selling value of it, would be the test of the damage his clients had sustained. He introduced much testimony to show at what price, per horse power, mechanically or electrically transmitted power was actually sold in the Blackstone Valley. Witnesses for the petitioners freely admitted that the cost of producing a horse power by steam was very different at the different mills; in fact, there could be no comparison between the cost at the least economical plant and that at the most economical plant. It is probable that no attempt would have been made by them to combine these costs in a class, and average them to find an average cost which it would do to call the market value, had there not been so many other mills of all sizes to be considered by the tribunal at the same time.

None of the witnesses for the city would subscribe to the theory thus advanced. Most of them, however, fell into trouble when the plaintiffs' attorney asked, in one form or another, the following question:

"A man has got 100 horses here in Worcester. Somebody comes along and takes away 50 of them; he is liable to him for doing it. Now, the

horses, we will assume, are worth $100 apiece in Worcester in the market. Ought he to have $100 apiece for those horses or $50 apiece, because he has got a ranch somewhere in the West where he can produce them and get them to Worcester for $50?"

When, however, the witness is off the stand and in the quiet of his own fireside, it does not seem difficult, at least to the author of the paper, to point out the real bearing of the question on the theory of the defence. Mr. Rockwood testified for the city, under the wing of its senior counsel, Senator George F. Hoar, and his explanation is therefore particularly interesting. A man has on sale a horse, fairly worth in the market twice what it cost him. If the horse is taken by the State, it is the law in Massachusetts that the State shall pay, as damages, not what it cost the man, but what he could naturally have sold it for.

The plaintiffs' attorney meant to have the city's witnesses substitute a horse power for the horse, in his illustration. The conclusion would then be irresistible that the cost of producing a horse power was not the measure of the petitioner's damage. Instead of depending on the cost, the damage would depend on what a horse power could be sold for in the horse power market. Now, the defence claimed from the beginning that no horse power had been taken. Water had been taken. But the petitioners only possessed the right to extract energy from that water, perpetually falling at their premises. In diverting the water the city took away this right. Then why should the city not pay the fair market value of this right? In truth, it is this right, according to the theory of the defence, that is by the power taken by the State, and this right is technically described as an easement to an estate.

How shall the fair market value of this easement be determined?

Generally speaking, it is impossible to cipher out with mathematical accuracy the fair market value of an easement. Commercial witnesses are called in to express their opinions of the value of the estate before the easement was taken, and the value left to the estate after being deprived of the easement. The difference is the value lost by the estate. That is to say, it is the fair market value of the easement.

It so happens that in the case of the particular kind of easement under consideration it is possible to prove, by mathematics and data in the possession of qualified engineers, that its value cannot exceed a certain fairly definite annual sum of money. Its actual value may easily be some lesser amount than this limiting value. The reason is that when the work is done by nature, it must be done in a particular locality; while if done artificially—by the combustion of coal—a great advantage is gained in being able to select a site for manufacturing purposes unhampered by a lack of water for power.

If each petitioner were supplied perpetually with coal in sufficient daily quantities to provide the same quantity of energy at a steam engine flywheel as was yielded at the water wheel shaft by the water diverted, he would obviously be fully compensated for his loss, other things being equal, and perhaps much more than fully compensated. But other things are not equal, and he may require a further sum before his total loss is made entirely good to him. How much this extra sum will be must depend upon conditions, which will vary with every case, respecting the amount of water diverted; the maximum and minimum flow of the water before and after the taking; the size of the water power, and the size of the necessary auxiliary steam plant. It may be that the quantity diverted is so large a proportion of the whole as to leave no value to what remains; or that the turbines formerly used were too large to be used efficiently after diversion. These are details of relatively insignificant importance.

The fact is that the greatest cause of the disagreement between the two sides, in the Kettle Brook water cases, is traceable to the lack of positive knowledge, on the part of both sides, as to the actual available quantity of water flowing each day in the year at each privilege. The petitioners claimed that the amount was 5,500,000 gallons per day throughout the working days in the year; that is to say, it was a fixed and invariable quantity. But while the civil engineers who testified for the city allowed 5,500,000 as the correct figure for the average flow, they claimed that there were frequently whole days when there was practically no flow of water at all.

Now, if the flow was fixed and invariable in amount before the taking, then the average annual damage per horse power, $50, assessed by the steam engineers who worked on that hypothesis, was correct, even if judged by the theory of the city's witnesses. They would admit, that is, that it would cost, on an average, that much per annum to develop a horse power by steam at the average of these privileges. The steam engineering experts for the city, however, assumed that the flow of water at each privilege was so unsteady as to make a steam plant necessary, if the water power were to be used at all; hence only coal was saved by this use of the water.

Stray Currents and the Stability of Structures.

Engineering says that the electrical current, though a century old, has lost but little of the mystery which surrounded its early years. The nature of electromotive force, the seat of this so called "force" in a Voltaic element, and the theory of the cell itself, are matters that are still open to discussion. Though much has been written at home and abroad about these electrical fundamentals, there is evidence that something remains to be done, and much to be said, before a settlement is reached.

As a consequence of this incompleteness of knowledge, the current itself is a phenomenon whose intimate nature is very imperfectly known. But this need not exert any depressing influence on the student of science, for the same may be said of many other subjects about which, nevertheless, we are accustomed to write very fluently, such as matter, force, energy, and gravitation. It is, no doubt, desirable in the interests of the philosophy of science to have clear concepts about the constitution of the world that surrounds us; but, on the other hand, such familiar acquaintance with the inner workings of Nature is not necessary for the successful application of any physical agent to the wants, comforts, and superfluities of life. The Professor of electrical theory may, indeed, be expected to enrich the world with his speculations about the origin and mechanism of the electrical current, but the ordinary man finds more than sufficient occupation for his professional and leisure hours in dealing with its various forms, transformations, and vagaries.

While the current freely acknowledges the authority and supremacy of Ohm's law, it shows itself now and again capable of astonishing even an expert by its caprices, and setting his detective qualities at defiance for a time. This is due in most cases to the provoking tendency which it has for making the acquaintance of neighboring conductors, whether linear or massive, solid or liquid. It threads its way through the most tangled network as easily as through a vulgar bifurcation. Not only does it take cognizance of the heart and surface of a conductor, but makes itself felt in the surrounding region which it fills with a whirl of magnetic lines. It welcomes moisture, for then it can go far abroad and break into countless stream-lines of every degree of curvature. Last year Professor Rücker was able to detect the magnetic field due to an overhead trolley wire a mile and a half away. Sir William Preece, while experimenting, in 1894, on wireless telegraphy, found currents on the surface half a mile back of the earthplates which were 1,200 feet apart.

Magnetic lines tend to spread out from the conductor as if in search of the stray filaments from other "fields" with which they are ever ready to interlace. Such intrusion of lines and insidious currents usually causes irritation in the physical laboratory and annoyance in the magnetic observatory. The introduction of dynamos a few years ago in St. John's College, Oxford, interfered considerably with the work of the students, and it was not until the laboratory was screened from the excessive curiosity of the dynamo lines that the disturbance was eliminated. The screening was effected by building up a double wall of separation between the rooms and filling the enclosed space with scraps of iron. The same mode of protection is not available for magnetic observations, as iron cannot be used in their construction. In building the Toronto observatory, the stone was magnetically tested, blocks showing traces of iron being rejected. In the Cavendish laboratory, Cambridge, even the hot water pipes are made of copper.

Despite the care bestowed on the erection of observatories, and the sums spent in their equipment, several of them have been so far interfered with by the proximity of wires carrying heavy currents that they have suspended, or are on the point of suspending, their observations. Our own national observatory at Greenwich is threatened in this way, the magnetic instruments being disturbed by the passage of trains on the London Electric Railway, although 4½ miles away. The Toronto observatory is worse off, being within 700 feet of the electric cars. Here work has been discontinued, and a valuable record thereby interrupted. The same is, unfortunately, true of the Naval Magnetic Observatory on the Georgetown Heights, Washington, the trolley being 1,400 feet distant. Professor Mascart repeated the same lamentable story before the Académie des Sciences a twelvemonth ago in respect to the recently equipped observatory of the Parc St. Maur, which is half-a-mile from the Paris electric tramway. In our case the state of affairs is about to be investigated by a committee appointed by the Board of Trade, and comprising names of the highest eminence. A great deal of assistance is to be expected from their report, always supposing that the problem is soluble. One thing is certain, the electric railway has come to stay, and that its progress cannot be stopped on

account of its interference with the magnetic observations. There are plenty of places in the world which will always be practically free from the disturbance of stray currents, and if no other remedy can be found, the observatories will have to be moved further afield.

Such a change would involve much inconvenience, and if electric traction systems must be extended both for the good of companies and the comfort of the public, it is none the less a matter of deep regret that work which has been carried on with scrupulous care for a great number of years, and which is of the highest scientific value, should be permanently interrupted or even temporarily interfered with. We know but too little of the magnetic conditions of our globe to lose any of the few stations in which the magnetic elements and their variations are daily and nightly recorded. From the publication of Gilbert's great work, just 300 years ago, interest in this subject has never been wanting; but we see it to-day taken up in every country with unprecedented eagerness. Every expedition to high latitudes has its full allotment of the finest instruments. Continental countries have, for the most part, been magnetically surveyed. Professors Rücker and Thorpe have done the same for Great Britain. In America, the work has been zealously carried on for years by the Coast and Geodetic Survey. Two large volumes have been published under the direction of Dr. Mendenhall, giving the elements for the cities and a great many country places in the United States, as well as beautiful charts showing ing the isogonic, isoclinic and isodynamic lines for the epoch 1900.

And still the need is felt for more knowledge, more details, more observations of local peculiarities, including the study of coast lines and rocks away from land. It is only when the continuous records of observatories have accumulated, and data, obtained in the field, greatly increased, that mathematical physicists can, with any chance of success, proceed to discuss these observations; and, integrating them with respect to time and place, draw safe conclusions as to the general distribution of magnetism over the earth. The stray currents which show themselves so unfriendly to magnetic observatories and research laboratories, are equally hostile towards our underground system of water pipes, gas mains, supports of elevated railroads, anchors of bridges, and the like. Escaping from the rails of trolley lines, they make use, on their way back to the central station, of every convenient conductor which they chance to meet. The earth is always a favorite on account of its high conductivity, for which it is indebted chiefly to the moisture which it contains. The embedded pipes, enjoying as they do, on their own account, the same electrical privilege, are pressed into the service and made to convey their proportionate share of the returning elements of current. Ohm's law determines exactly how much each conductor will carry, and likewise how far it will have to bear its electrical load without assistance.

As long as a current is confined to a conductor it produces no evil effect; but it is otherwise at the places of entrance and exit; it is there the damage is done. The former acts as the cathode of a large electrolytic cell, consisting in order of rail, moisture and pipe; the latter acts as the anode of a cell made up of pipe, moisture and rail. When the current passes, the salts dissolved in the moisture are decomposed, the products of the analysis appearing only at the terminal metals. At the cathode, oxygen is set free as a secondary effect, and the pipe accordingly dissolves. At the anode, oxygen, chlorine and various acid radicals make their appearance. These are the chief mischief workers. They vigorously attack the metal, corrode it and waste it away. The amount of corrosion will depend upon the strength of the current flowing from a given area and the nature of the salts contained in the soil. The chlorides stand first in order of activity, then come the nitrates, and last of all the sulphates. Most soils contain soluble salts of potash, soda and ammonia.

It has been estimated that a current of an ampere will dissolve in a year 20 pounds of iron or 75 pounds of lead. But it does not require an ampere to effect such havoc; a mere directive electromotive force is sufficient to start the electrolysis. The work of corrosion will then proceed slowly, but its cumulative effect will not be a negligible quantity. Fortunately there is a remedy for the insidious and pernicious work of stray milliamperers; and it is as simple as effective. The electrical tyro will name it at once, and so probably will the least technical member of a board of directors. Avoid all "earths," they will say, make your circuit metallic throughout, and you will have the best protection possible for all underground conductors. The financial committee will also be found highly appreciative of the efficiency of the remedy; but they will tell you that the market price of copper is so high that they cannot entertain the idea of duplicating the conductors. This being the case, all that can be done for the present to check the fragmentary tendencies of the return current is to use heavy bonding.

There is hope, however, that the radical remedy may yet be applied by the help of that new product of the electric furnace, aluminum. It is cheap, light, and of good tensile strength. Its conductivity, it is true, is only 63 per cent. of that of copper, but this drawback may be overcome by a suitable increase of cross section. Further experiments and trials are needed to test how far aluminum may successfully replace copper for insulated as well as for bare conductors, both overhead and underground. If they confirm present expectations, we may soon see an end put to the destructive effects of stray currents.

The latest outcry against them comes to us from New York, where certain authorities seem concerned for the stability of the Brooklyn Bridge and the adjacent sections of the Third Avenue Elevated Railroad. Previous to the recent adoption of electricity, the bridge cars were operated by cable; but even then currents escaped from the Brooklyn trolley lines, crossed the bridge, and entered the elevated structure. From this they passed into the underground system of pipes, and thence back through the earth and the East river to the power station in Kent street, Brooklyn.

Since the trolley cars have been allowed to cross the bridge, and the cable discarded for electric traction, the trouble has been aggravated and extended. Complaints having been made from time to time by many parties interested, the State Board of Railroad Commissioners have at last caused an inquiry to be made as to the seat and extent of the evil. The investigation was intrusted to Mr. C. R. Barnes, an electrical expert, who, after months of testing and examining, has handed in a valuable report. As expected, he found a current constantly flowing from the bridge terminal into the iron structure of the City Hall station of the elevated road. On leaving the supporting columns for the earth, it was found to flow under a pressure of 2½ volts. This maximum difference of potential fell off with distance from the bridge. The currents were followed to the gas mains and water pipes in Park Row and Chatham Square, where evidence of electrolytic action was found, as well as at the bases of the columns in the vicinity of the bridge. It must be remembered that it is the amperes which do the damage, and that they depend not only on the voltage, but also on the resistance of the intervening medium.

As to the bridge itself, the chief seat of danger is at the anchors, of which there are four on each side of the river, weighing 23 tons apiece. In the case of leakage, they would act as massive anodes, the bolts and fastenings gradually deteriorating. It was not thought advisable to suspend the traffic between the two boroughs in order to allow excavations to be made, so that the actual condition of these parts, which are of such vital importance to the stability of the bridge, has not been ascertained. If the concrete in which they are deeply embedded has proved impervious to moisture, very little injury can have been done; but if otherwise, even to a small degree, the consequences must be disastrous in course of time.

Mr. Barnes concludes his report by the comforting statement that he finds no serious damage to have been caused by electrolysis to the supports of the Manhattan Railway Company's works. He, however, recommends that the structure be immediately placed in such condition that, at no point, will it be positive to other conductors in the ground, more than a volt. But the directors of the Manhattan Company may reasonably object that it is not for them to apply the remedy since they are the sufferers. The cause of all the injury done is leakage from the bridge. Let that be abolished by the Brooklyn Rapid Transit Company, and the evil will disappear at once.

In justice to this company, it must be said that they have already taken means to minimize the trouble. They have retracked their whole system with massive and heavily bonded rails, and quite recently the eight lines of the bridge were electrically connected together at the Brooklyn side with a stout copper cable, the other end of which was thrown into the East river and there fastened to large masses of iron. Should these improvements fail to check the expansiveness of the return current, the use of the rails must be abandoned and the circuit insulated throughout. But by that time we shall know more about the mechanical and electric properties of aluminum. Present prospects encourage the hope that it will show great adaptability to the wants of electrical engineering, and perhaps prove the panacea of our present electrolytic troubles.

SPECIAL ENGLISH CORRESPONDENCE.

COMMUNICATED BY NORTON H. HUMPHRYS.

SALISBURY, ENGLAND, Dec. 10, 1899.

The Rochdale Road Disaster.—Self-Igniting Burners.—That Electric Light Again.—The Protection of Property Act, 1875.

The legal aspect of the fatal disaster at the Rochdale road gas works at Manchester, has been closed by the finding of the coroner's jury. That body has declared a verdict of "accidental death," with a rider to the effect that "Jones was deserving of severe censure by the coroner for his thoughtlessness in removing the pump without leave." The facts are of a clear and simple character. A building hitherto used as a meter and governor house was to be discarded so far as that purpose

is concerned. In front of the central portion of the building was a projecting portico which also formed the base or pediment of a handsome clock tower. A 24 inch outlet main was carried out from a governor situated in the building, for the supply of gas to the district, and the work in progress was the isolation of this governor and the cutting and stopping off of the 24-inch pipe. For this purpose it was plugged by means of an indiarubber bag inserted in the usual way, and inflated by means of a force pump. The pipe was cut, and the work of bricking up the open end was more than half completed. One is tempted to ask why this tedious method was adopted in preference to the more expeditious plan of using a cap or plug of cast iron, and no doubt a satisfactory explanation would be forthcoming. At this stage of the proceedings the man Jones, who is described as a stoker, comes on the scene. Most unfortunately, Jones appears to have remembered that the force pump might be required in the retort house in the course of an hour or so. This was a matter easily dealt with, and one would think he would point out his position to one of the superiors present and ask for instructions. Instead of taking that obviously plain and proper course, he was "thoughtless" enough to come up behind, taking advantage of a moment when the man who was using it to keep the bag inflated was speaking to Mr. Stevenson, snatch the pump, without saying a word to anybody, and that with such violence as to break off the rubber connecting tube near to the neck. I have cavilled at the expression "accident" as inapplicable to the occurrence, and also disagree with the appropriateness of the expression "thoughtlessness," as describing the act of Jones. The bag speedily collapsed under the back pressure of gas, which was about 20-tenths, the gas escaped rapidly from the half closed pipe, ascended the clock tower and was fired at a flash light, with the consequences already described.

The coroner, in instructing the jury, advised them that it was their duty to consider whether Jones was merely negligent or careless, or whether he had been recklessly careless. If they decided that he was determined to have the pump, whether in use or not, and without regard to the consequences of taking it, they would have to return a verdict of manslaughter. But if he simply took the pump under the mistaken view that it was not in use, there was no criminal recklessness. The jury, as we have seen, inclined to the latter opinion, which the coroner, in addressing Jones, described as a very merciful view of the case. He hoped it would be a warning that it was the duty of all those who work in a place like a gas works not to neglect the slightest precaution in providing for the safety of others. Perhaps we here have the most important lesson to be gathered from this very regrettable occurrence—and no one probably regrets it more deeply than Jones himself.

The tendency of the age is not only to get as high a rate of wages but to do as little as possible in return. Men object to the slightest interference with their regular routine, if it means wheeling a barrow another two yards, or remaining at work for ten seconds after the closing bell has begun to ring. Employers have been sternly reminded by the Liability Act of their duties and responsibilities as regards the safety and well being of those employed by them. And the man Jones is not the only workman who needs a similar reminder to the effect that workmen have their responsibilities, not only as regards their employers, but also in relation to those working with them.

Last month I had a little to say respecting the steady growth of incandescent gas lighting in public favor, and in addition to this, a marked development in the adoption of self-lighting burners is especially observable. The by-pass or flash-jet burner is at best only an apology for a self-lighting arrangement, though perhaps a fairly passable one. But it is not the real Simon Pure, and such a device, to be a success, must be actuated by one simple turn of the tap. Anything of a more complicated nature is not likely to come in for more than a very limited degree of favor. So, in speaking of a self-lighting burner, I refer to one in which actual ignition ensues on turning the tap, there being absolutely no consumption of gas while the burner is not in use, and the manipulation of which is confined to a single movement of the tap. The patent records show a great deal of ingenuity as applied in meeting the essential condition that the igniting pellet shall be out of contact with the working flame. The self lighting device has a marked effect on the cleanliness of the globe or shade. These appliances frequently bear prominent sooty traces from the flame of the taper or the match applied in lighting them, and careless lighting is frequently a contributing cause to the black patch on the ceiling above the burner. The tap is turned on first, then the match is struck, and ignition is attended with a small explosion that produces a fine cloud of soot, some of which is deposited on the shade or chimney and some escapes to the ceiling. Self-igniting burners, even after several months' use, are free from the grime or soot which is so frequently a disfigurement of the gas burner and its accessories.

As usual at this season of the year, the electric light has furnished some amusing instances of its uncertain character. I have not heard that, so far, it has suffered total eclipse in a place of worship, just after the preacher had announced for his text, "Let there be light," or some similar expression, of which several examples were recorded last year. But if it so far advanced as to show a decent respect for religion, there is still room for some improvement in its behavior as regards temporal dignitaries. In a Court of Assizes at Cardiff, the other day, it developed qualities the reverse of that special steadiness which its votaries claim as one of its numerous advantages, to such a marked degree as to call for special comment from the bench. In Cheshire, it collapsed entirely just as a meeting of the District Council was about to be held, and the chairman was ushered to his seat by the light of the reliable if not dignified tallow candle, hastily improvised lights of a similar humble character serving to make darkness visible. The members of the Corporation of the City of London, at their last meeting, were well into work when the electric lights totally failed and candles had to be sent for, in order to enable the business to be completed. Then there has been a fire at Hull, partial failure of the light at Birmingham extending over an hour and a-half, and a complete stoppage for an hour at Halifax. A singular feature here was that the street cars are also worked by electricity, and the stoppage was attended by the stranding of the cars, many of which happened to be in the middle of crossings and in other ways not in a convenient position for a stoppage.

Some 27 years ago, on the occasion of a labor dispute, a large number of workmen struck work, and the consequence was that the gas supply to the City of London was nearly eclipsed. The injury to manufacturing interests, the great risk of danger at railway stations, the serious difficulties at the General Post Office, and other public establishments, to say nothing of the inconvenience suffered by the ordinary householder, and the facilities afforded for crime by having the public thoroughfares in complete darkness, had a very marked effect on the public mind. A demand at once arose for some public measure for ensuring the safety of such an important matter as the general gas supply, and for placing it beyond the control of a combination of more or less ignorant working men. And the result was the "Conspiracy and Protection of Property Act, 1875," under which any concerted action having for its object the stoppage or diminution of the gas supply became a penal offence, punishable by fine or imprisonment. It is evident that the unrestricted possession of such a powerful weapon as the control of the public gas supply, would enable the holder to dictate his own terms.

So far the Act has proved satisfactory, as proceedings under its provisions have been few and far between. There have lately been some disagreements with the men employed by the Corporation gas works at Glasgow, which culminated on a recent Sunday night by a large number of men suddenly throwing up work, and that without regard to the fact that their engagements were subject to fourteen day's notice. Sunday night, it need scarcely be observed, was a time when the consequences of such an act would be aggravated by the difficulty of getting substitutes, and, further, the question was not one of work or of wages, but hinged upon the right of the Corporation to employ non-union men. The result was that eight of the ringleaders were called upon to appear at the Sheriff's Court to answer a charge of controverting the 1875 Act, by which they had laid themselves open to a fine not exceeding £20, or to three months' imprisonment with hard labor. The facts were not disputed. The defendants pleaded guilty, and all that their advocate could urge in their behalf was that it was not so much a strike as a delay to begin work. They had no complaint as to rates of pay or conditions of labor, but the grievance was the employment of one particular man, and instead of fulfilling their allotted tasks they discussed the matter. After a few hours they offered to work, but were refused. All this did not satisfy the Sheriff, who thought that something less than the full penalty would be sufficient to act as a warning to the remainder. One man was find £7, three others £5 each, and the charges against the others were withdrawn.

THE new rates for the supply of electric light in Passadena, Cal., which went into effect the 1st inst., do not seem to meet with favor from the residents. The differences seem to arise from the fact that contract rates are rather more to the taste of the ordinary user of current than are meter rates. Of course, the difference is chargeable to the belief of the consumer that he is a much better measurer of that which he uses on lighting account than any mechanical measurer that as yet has been devised. The gas men have been through this sort of thought; in truth, they still encounter some who hold that gas meters are "not in it" with the measure of the gas that the consumers "did not use."

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

A CORRESPONDENT, writing under date of the 13th inst., says: "I have to tell you of the death of Mr. Lewis W. Gould, Manager and Treasurer of the Vineland (N. J.) Gas Company, whose passing away happened something less than a fortnight ago. To be precise, the evening of the 1st inst. I looked for some notice of the sad affair in the JOURNAL, failing which I thought the news might not have been known to you. Deceased was for years prominent in the best business and social life of South Jersey, and his untimely death is mourned by many. His widow survives him."

"E. S. F." is informed that the dissolution of the E. C. Perry Supply Company, of Dunkirk, N. Y., has made no difference in the management and ownership of the Dunkirk gas works, which continues to be conducted by the firm of E. C. Perry & Co.

THE Troy (N. Y.) Gas Company will construct a new holder, the contracts for which have been awarded. The vessel will be put on the plot on Turner street, recently purchased by the Company from Messrs. B. Cooper & Co.

WE regret to have to chronicle the death of Mr. C. H. Carter, Superintendent of the Clarksville (Tenn.) Gas Light Company, whose demise occurred at his home, South First street, Clarksville, the evening of the 9th inst. He assumed the Superintendency of the Clarksville Company about a year ago, prior to which time he had been in the service of the Citizens Gas and Electric Company, of Jacksonville, Fla. Deceased was born in Lebanon, Tenn., August 22, 1863.

THE Berlin Iron Bridge Company, of East Berlin, Conn., is about to complete, for the American Ordnance Company, of Bridgeport, Conn., a new machine shop, with traveling cranes, runways, etc. The building will be covered with the Bridge Company's patent anti-condensation corrugated iron roof covering.

THE proprietors of the Hannibal (Mo.) Gas Light and Coke Company will expend a considerable sum next season in bringing the manufacturing and distributing plant up to the demands of the residents for its product. The business of the Company has prospered much the past year.

MR. WILLIAM A. HEARNE, for many years a trusted employee of the Haverhill (Mass.) Gas Light Company, died at his home in that city the morning of the 10th inst. He was in his 65th year.

THAT peace hath victories no less renowned than those of war is again shown in the re-election of Brigadier-General Charles C. Fry to represent the Fifth Ward of Lynn, Mass., on its Board of Aldermen. General and Alderman that he is, our own Mr. Fry is better known to the gas men of America as the level-headed Secretary and Treasurer of the Lynn Gas and Electric Company.

MR. J. G. FELKER, of Detroit, Mich., has been appointed Manager of the Bowling Green (Ky.) Gas Light Company, vice Mr. Arthur Jamison. Mr. Jamison has accepted a responsible position with a Pittsburg (Pa.) manufacturing concern.

A PARTY by the name of C. W. Smith has applied to the City Council of Moline, Ills., for the right to operate an opposition gas plant in that place. His enterprise bears the baptismal title of the "Moline Hard Coal and Gas Company." He has, according to our advices, but little chance of obtaining the coveted grant.

THE Matchless Gas Igniting Company has been incorporated in Trenton, N. J., with a capital of $200,000. According to the articles, the purpose of the Company is to "manufacture gas burners and fixtures for lighting gas without matches."

THE Long Beach (Cal.) and Alamitos Gas, Electric and Power Company has filed articles of incorporation. The moving spirits are Messrs. F. H. Ringe, G. I. Cockran and H. V. Carter. Its capital is put at $100,000.

MR. B. F. ELLISON, formerly Treasurer and General Manager of the St. Paul (Minn.) Gas Light Company, will assume the duties of General Manager of the Superior Water, Light and Power Company, of West Superior, Wis., the first of the new year.

MR. HORACE W. WALDRON, since 1893 General Manager of the Portsmouth (N. H.) Gas, Electric Light and Power Company, has accepted a responsible position with a manufacturing concern in Boston, Mass. Mr. Waldron goes to his new field the first prox., and the best wishes of a host of Portsmouth friends accompany him, that his success in Boston will be equal to that achieved by him in Portsmouth.

THE proprietors of the Oroville (Cal.) Gas and Electric Light Company have decided to increase the electric lighting division of the plant, especially in respect of its capacity to supply lamps of the incandescent sort.

MR. A. L. RICE, of Riverside, Cal., has purchased a controlling interest in the gas plant for Selma, Cal. Mr. Rice, as we understand it, will take personal charge of the Selma Company's business, removing to Selma about February first.

THE regular quarterly dividend of 1½ per cent. on the shares of the Toledo Gas Light and Coke Company is payable on demand. The Company's affairs and trading are in better shape than ever, despite the natural gas antics that have been shown there for the past few year's.

THE regular quarterly dividend of 2 per cent. on the shares of the United Gas Improvement Company is payable January 15.

THE Louisville *Post* and a correspondent are our authorities for the following: "The contention between the Kentucky Heating Company and the Louisville Gas Company is again in evidence. Some days ago the Board of Public Works again refused to grant any permits to make the service connections to the mains of the Kentucky Heating Company, which action was based on the ground that natural gas was constantly being used for illuminating purposes, instead of being used for heating purposes only. Last summer the Board took similar action, but afterwards did not maintain the position. When interviewed over the matter, Mr. Grainger, Chairman of the Board of Works, said: 'We refused the Kentucky Heating Company authority to make any more service connections because the Company has violated not only the ordinance governing the case, but its agreement made with us last summer as well. When we finally reconsidered our first decision some months ago, and allowed the Heating Company permits, it was upon the express understanding that its gas was not to be used for illuminating purposes, but simply for heating. Finding that this agreement had not been lived up to by the Company we declined to grant it any more permits.'" It looks that the Heating Company will in the end have to live up to the spirit and letter of its charter. The matter of this contention, which was explained at length in the JOURNAL for May 1st and 15th, 1899, is now before the courts, whose opinion thereon will be received with interest by the fraternity at large, since the verdict will, in more than one instance, affect natural and illuminating gas supply in States other than that in which the issue was raised, especially keeping in mind the original charters of the companies concerned.

MAJOR KNAPP, whose management of the Gas Light Company, of Augusta, Ga., seems to merit the approval of its proprietors and the favor of the residents, is putting in big strokes this winter towards inducing the Company's patrons to keep up their use of gas for cooking, and heating as well. Intermittent heating is the rule in a Georgia winter, and Major Knapp insists that intermittent heating can be accomplished better through gaseous fuel than by the use of "pine knots," "soft-hard" coal or pan-handle coke. And at not so much greater cost, either.

THE proprietors of the Hudson County (N. J.) Gas Company will, on January first, open another branch office at 751-53 Montgomery street, Jersey City. It is intended for the especial benefit of the residents of what is known as the Bergen district. The existing branch office, No. 116 Monticello avenue, will be closed January 1st.

MR. C. H. NUTTING, Superintendent of the Chicopee (Mass.) Gas Light Company, forwards us the following circular, issued by the Company under date of the first inst., which circular has in it much of plain, common sense notifications to gas users that the Chicopee Company is ready at all times to attend to their wants:

"The public are hereby notified that we have removed our office to No 11 Center street (next to First National Bank) where we have

(*Continued on page* 1019.)

THE AMERICAN GAS LIGHT JOURNAL

A. M. CALLENDER & CO.,
PROPRIETORS.

THOS. J. CUNNINGHAM,
ELBERT P. CALLENDER,
EDITORS.

CHAS. E. SANDERSON,
MANAGER.

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AGENTS:
New York—American News Co., 39 and 41 Chambers St.
Germany—Lemcke & Buechner, of New York.
England—Aug. Siegle, 30 Lime Street, London.

MONDAY, DEC. 25, 1899.

(*Continued from page* 1018.)

secured ample quarters to meet the growing demand that is continually being made upon us. All of the best gas appliances such as gas ranges, heaters, grates for fireplaces, Welsbach lights, portable stands, etc., are being carried in stock and are sold at cost. Patrons of the Company are specially requested to notify us of any leaks they may discover, whether from main or service pipes, also of any unsatisfactory service, and we will give prompt attention to remedying the same. Satisfactory gas illumination depends very much upon the condition of distributing pipes and burners and frequently the quality of the gas is condemned when the difficulty is wholly local, and due to pipes being clogged, or of inadequate size, or to the burners. While consumers are responsible for the cost and maintenance in good working condition of the burners, and the distributing pipes from the meters to the burners, all necessary repairs or changes of the same will be done by the Company at the lowest possible cost of labor and material. An extra charge of 10 cents will be made for each mantle installed by the Company. Office hours: 8 A.M. to 12 M; 1 P.M. to 5:30 P.M. Evenings, from 5th to 10th of each month, from 7 to 8 P.M." One fault in the circular that might be named is in the sentence which specifies an extra charge of 10 cents for each Welsbach mantle installed by the Company. A cherry will not stand two satisfying bites.

MR. ROBERT MCKNIGHT, who, in 1848, constructed or supervised the construction of the gas works in Bellefonte, Pa., died in Bellefonte about a fortnight ago. He was in his 82d year.

WESTERN parties are concerned in a movement to secure control of the gas and electric lighting properties of Winchester, Va.

AT a recent special meeting of the shareholders of the Warren County (Pa.) Gas Company it was decided that 7 instead of 15 Direc tors shall serve the Company. The 7 chosen were : Liddon Flick and R. J. Flick, of Wilkes-Barre ; W. F. Culver, Edward C. Jones, and Thos. F. Lozier, of New York ; and W. H. Walters and Clarence Walters, of Easton.

THE Roseville and Crooksville Gas Company, of Roseville, O., has been incorporated. It is capitalized in $50,000.

MR. GEORGE DANFORTH will be retained as Manager of the properties of the Decatur (Ills.) Gas Light Company, which went into new ownership recently.

A SLIGHT explosion occurred some days ago in the purifying plant of the Ann Arbor (Mich.) Gas Company. The damage to property was less than $100 ; to person, none. One who chanced to read in the "Assoc.ated Press" despatches some account of the affair could readily be forgiven for believing that the Ann Arbor plant was completely knocked out ; but it wasn't, more's the joy.

MANAGER CASE, of the Duluth (Minn.) municipal gas works, reports that the output in November, 1899, was 3,468,000 cubic feet ; in November, 1898, the output was 2,467,000 cubic feet. Pretty good showing, that.

ANOTHER reduction in the gas rate for Binghamton, N. Y., will shortly be announced.

The Market for Gas Securities.

Last week's general share market will long be remembered by many. Distrust of everything and of everybody was the dominant feature, with the ghost of entombed money walking spectacularly. Early in the week the raid was started, and last Monday saw as fine a slaughter of gilt-edged securities as has been recorded for six years. Everything looked alike to the bear operators, and to their credit be it said they did their work well, although some of them lost a little for a while trading in Consolidated. Opening at 179 Monday last, by 2 P.M. it had been hammered to 168, and at the close it was 173¼. Since then it has been to 186, and at the end to-night (Friday) the quotation is 180 to 182. To our mind at such prices the stock is wonderfully cheap. Rumor and newspaper assertion seem to show that an arrangement of the gas muddle was all but completed last Thursday. However, it is now asserted the bargain will not be bound until to morrow. Standard issues were very weak, without good reason though, and Amsterdams were thin on their merits.

The general situation is, of course, through unsettled monetary conditions, all against buying for a rise ; but many gas specialties seemingly present great opportunities for profit. Peoples, of Chicago, for instance, as well as Detroit gas, Laclede common, and Western, of Milwaukee. The United Gas Improvement Company has declared its regular quarterly dividend of 2 per cent., payable the 15th prox. This Company's stock, which is quoted at 148 (on the par of 50), is easily worth 175.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

16 WALL STREET, NEW YORK CITY.

DEC. 25.

☞ All communications will receive particular attention

☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$39,078,000	100	180	182
Central Union, Bonds, 5's.	3,000,000	1,000	107½	108½
Equitable Bonds, 6's	1,000,000	1,000	105	.
" 1st Con. 5's	2,300,000	1,000	115	18
Metropolitan Bonds	658,000	.	108	112
Mutual	3,500,000	100	300	330
" Bonds	1,500,000	1,000	100	102
Municipal Bonds	750,000	.	..	.
New Amsterdam Gas Co.	13,000,000	100	20½	21½
Preferred	10,000,000	100	41	43
Bonds, 5's	11,000,000	1,000	88	90
Northern Union, Bonds, 5's.	1,250,000	1,000	95	97
New York and East River..				
Bonds 1st 5's	3,500,000	1,000	109	111
" 1st Con. 5's	1,500,000	.	112	114
Richmond Co., S. I.	348,650	50	70	..
" Bonds	100,000	1,000	..	.
Standard	5,000,000	100	..	95
Preferred	5,000,000	100	120	..
Bonds, 1st Mortgage, 5's	1,500,000	1,000	112	114
Yonkers	299,65	500	130	
Out-of-Town Companies.				
Brooklyn Union	15,000,000	100	134	134¼
" " Bonds (5's)	15 000,000	1,000	118	119
Bay State	50,000,000	50	1⅝	1⅛
" Income Bonds	2,000,000	1,000	..	75
Binghamton Gas Works	450,000	100	40	..
" 1st Mtg. 5's	475,000	1,000	96½	99½
Boston United Gas Co.—				
1s Series S. F. Trust	7,000,000	1,000	92	..
2d " " "	3,000,000	1,000	68	71
Buffalo City Gas Co.	5,500,000	100	9	11
" " Bonds, 5's	5,250,000	1,000	84	85
Central, San Francisco	2,000,000	..	106	108
Chicago Gas Co. Guaranteed Gold Bonds	7,650,000	1,000	104	104¼
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,207,000	1,000	106	108
Columbus (O.) Gas Lt. & Heating Co	1,682,750	100	60	65
Preferred	3,026,500	100	84	86
Consumers. Jersey City Bonds	600,000	1,000	102	105
Cincinnati G. & C. Co.	8,500,000	100	197	197¼
Consumers, Toronto	1,700,000	50	230	235
Capital, Sacramento	500,000	50	..	35
Bonds (6's)	150,000	1,000		..
Consolidated, Baltimore	11,000,000	100	50	..
Mortgage, 6's	3,600,000	..	..	118
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,490 000	..	..	112
Consolidated Gas Co. of N.J.	1,000,000	100	21	23
" Con. Mtg. 5's	380,000	1,000	87	90
Consolidated G. & E. Co.'s., Little Falls, N.Y.	90,000	100	..	100
Bonds	75,000	..	..	100
Detroit City Gas Co.	4,560,000	50	95¾	96
" Prior Lien 5's	4,598,000	1,000	99¼	100
Detroit Gas Co., 5's	386,000	1,000	100	101
" Inc. 5's	16,000	100	100½	101
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Fort Wayne	2,000,000	..	77	81
" Bonds	2,000,000	..	80	85
Grand Rapids Gas Lt. Co.	1,000,000	50	..	..
" 1st Mtg. 5's	1,125,000	1,000	..	..
Hartford	750,000	25	..	230
Hudson County Gas Co., of New Jersey	10,500,000	..	25	..
" Bonds, 5's	10,500,000	..	102	105
Indianapolis	2,000,000	..	122	128
" Bonds, 6's	2 650,000	..	105	106
Jackson Gas Co	250,000	50	72	78
" 1st Mtg. 5's	250,000	1,000	101	102½
Lafayette Gas Co., Ind.	1,000,000	100	68	70
Bonds	1,000,000	1,000	81	86
Louisville	2,570,000	50	106	
Laclede, St. Louis	7,500,000	100	75	
Preferred	2,500,000	100	98	
Bonds	10,000,000	1,000	107	
Madison Gas & Elec. Co.	400,000	100	82	
" 1st Mtg. 6's	250,000	1,000	102½	108
Montreal, Canada	2,000,000	100	200	..
Newark, N. J., Gas Co.	16,000,000	..	59	60
Bonds, 6's	4,600,000	..	107	108

New Haven	1,000,000	25	280	300
Nashville Gas Lt. Co.	1,000,000	50	110	..
Oakland, Cal.	2,000,000	..	43	45
" Bonds	750,000	..	..	..
Peoples G. L. & Coke Co., of Chicago	25,000,000	100	107¼	108
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	20,100,000	1,000	111⅝	111½x
2d "	2,500,000	1,000	104	105
Rochester Gas & Elec. Co.	2,150,000	50	88	..
Preferred	2,150,000	50	118	..
Consolidated 5's	2,000,000	..	87½	90
San Francisco, Cal.	10,000,000	100	55	57
St. Paul Gas Light Co.	1,500,000	100	57½	58½
1st Mortgage 6's	650,000	1,000	82	85
Extension, 6's	600,000	1,000	..	..
General Mortgage, 5's	2,498,000	1,000	88	90½
St. Joseph Gas Co.	1,000,000	100	42	44
" 1st Mtg. 5's	750,000	1,000	96½	98
Syracuse, N. Y.	1,750,000	100	15½	18
Bonds	1,612 000	1,000	81	84
Washington, D. C	2,600,000	20	285	..
First mortgage 6's	600,000	..	.	..
Western, Milwaukee	4,000,000	100	106¾	107¾
Bonds, 5's	3,830,500	.	106	108
Wilmington, Del.	600,000		220	50

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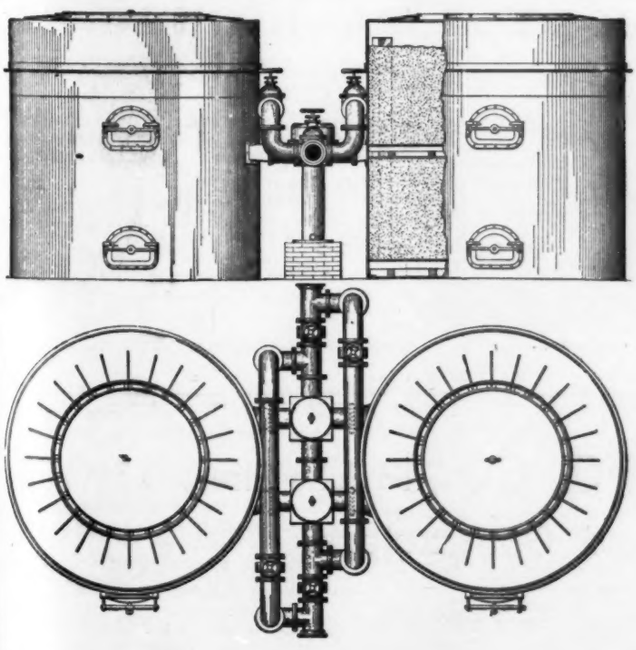

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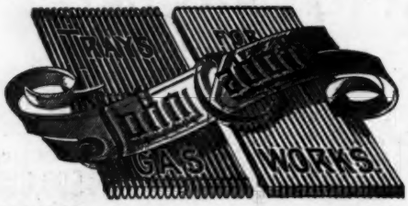

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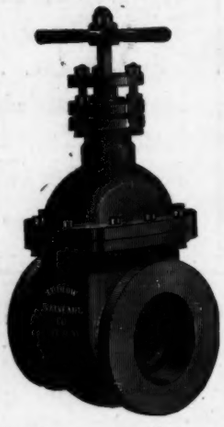

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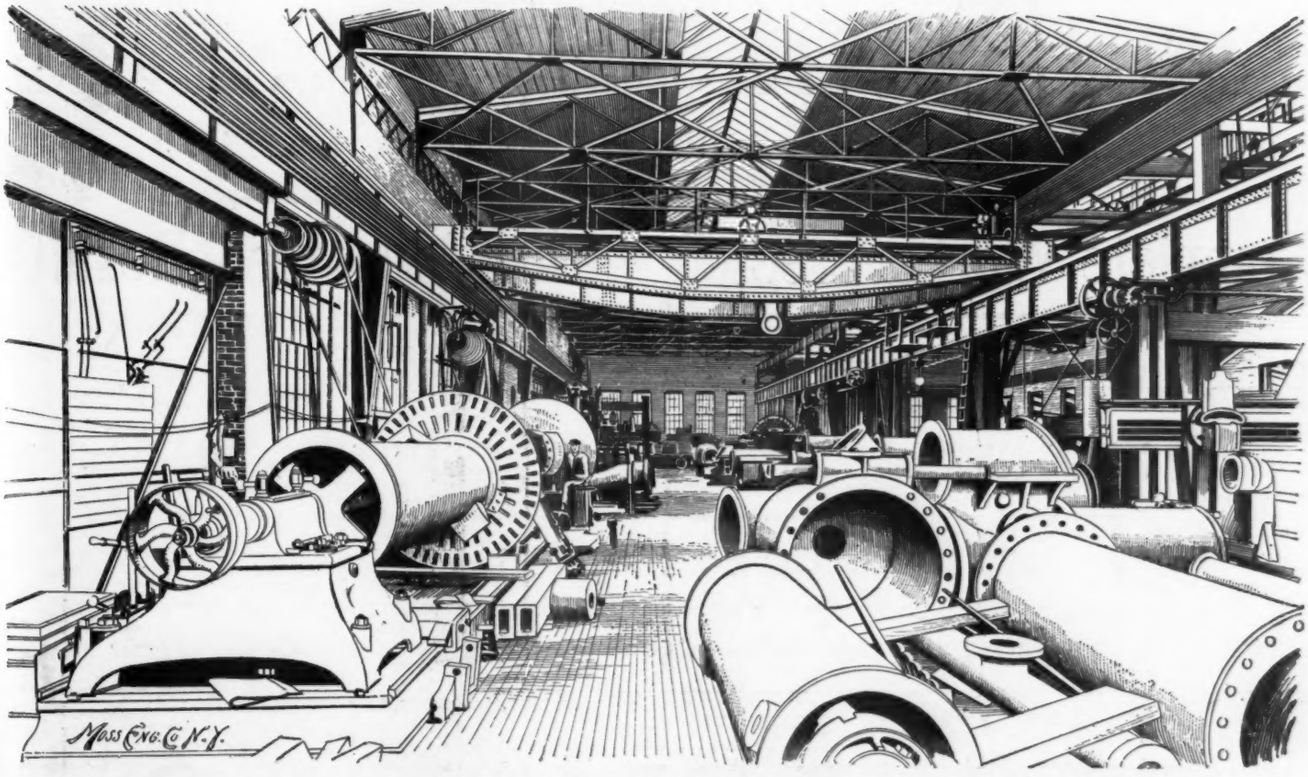

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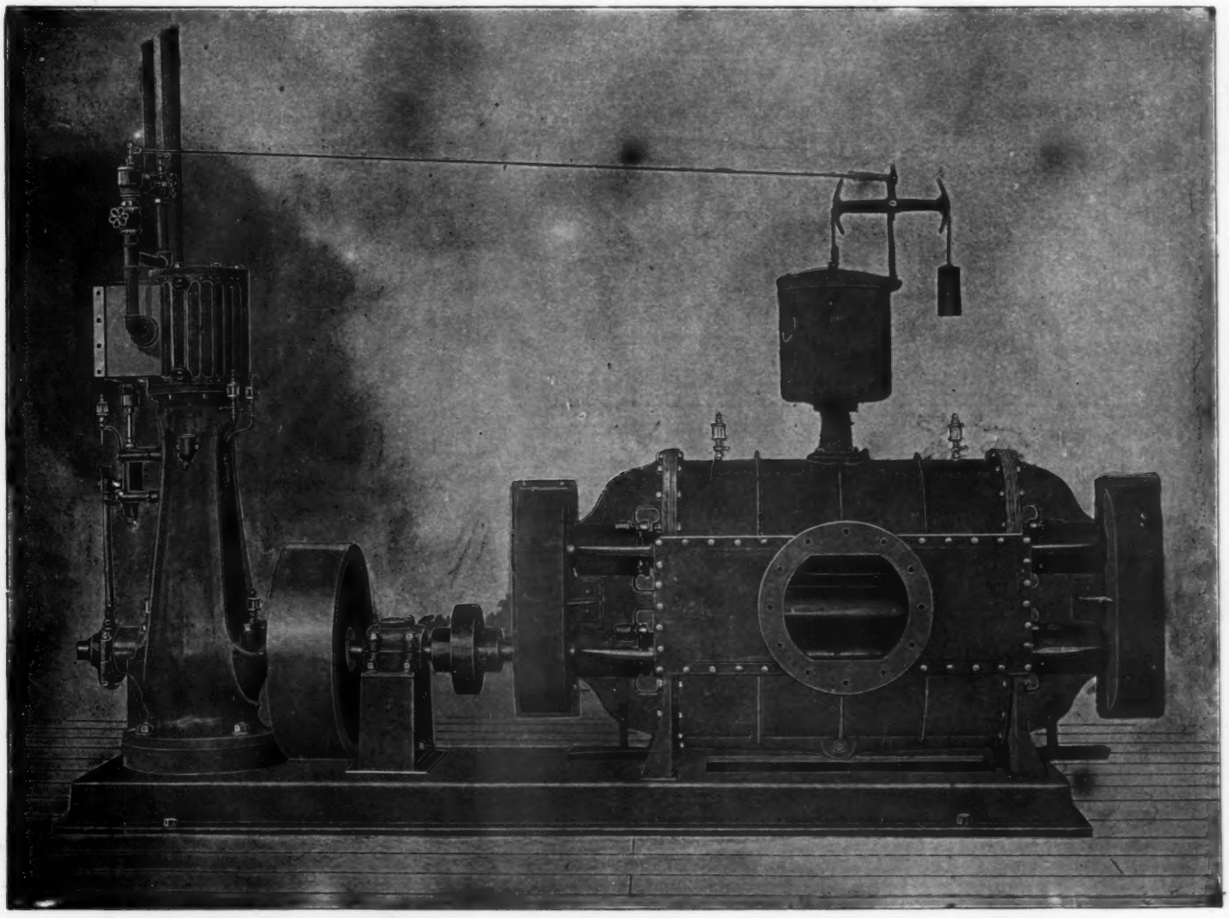

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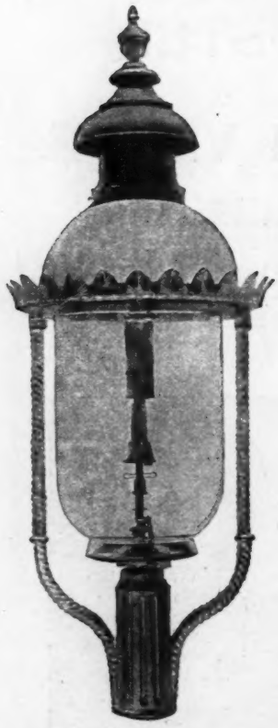
.... OF AMERICA ....



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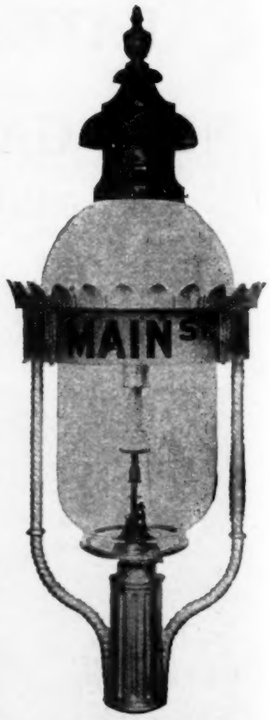
Where there are no gas mains we can furnish an equally good light by our SELF-GENERATING NAPHTHA WELSBACH BURNER, and thereby supply a uniform light in all localities.



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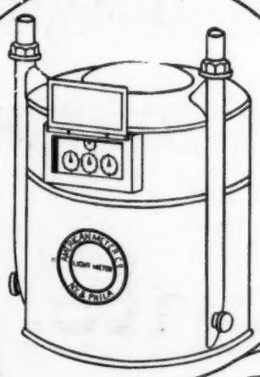
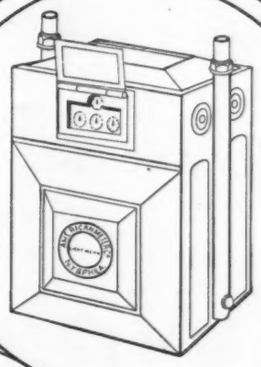
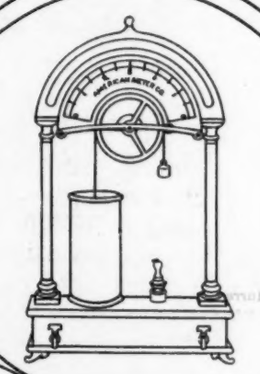


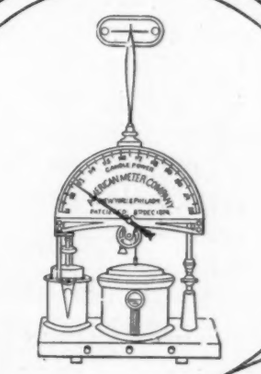


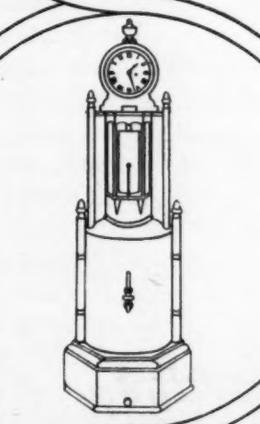
PUBLIC LIGHTING TABLE.

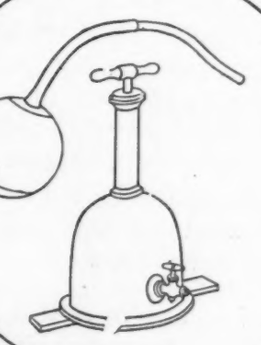
JANUARY, 1900.

Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Table No. 1. Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Table No. 2. Extinguish.
				P.M.	A.M.
Mon.	1	5.20 PM NM	6.20 AM	4.30	6.30
Tue.	2	5.20	6.20	4.30	6.30
Wed.	3	5.20	6.20	4.30	6.30
Thu.	4	5.20	6.20	4.30	6.30
Fri.	5	5.20	6.20	4.30	6.30
Sat.	6	10.10	6.20	4.30	6.30
Sun.	7	11.30 FQ	6.20	4.30	6.30
Mon.	8	12.30 AM	6.20	4.40	6.30
Tue.	9	1.40	6.20	4.40	6.30
Wed.	10	2.40	6.20	4.40	6.30
Thu.	11	3.40	6.20	4.40	6.30
Fri.	12	4.30	6.20	4.40	6.30
Sat.	13	5.20	6.20	4.40	6.30
Sun.	14	No L.	No L.	4.40	6.30
Mon.	15	No L. FM	No L.	4.50	6.25
Tue.	16	No L.	No L.	4.50	6.25
Wed.	17	5.30 PM	8.10 PM	4.50	6.25
Thu.	18	5.30	9.10	4.50	6.25
Fri.	19	5.30	10.00	4.50	6.25
Sat.	20	5.30	11.00	4.50	6.25
Sun.	21	5.40	12.00	4.50	6.25
Mon.	22	5.40	1.00 AM	5.00	6.25
Tue.	23	5.40 LQ	2.00	5.00	6.25
Wed.	24	5.40	3.00	5.00	6.25
Thu.	25	5.40	4.00	5.00	6.25
Fri.	26	5.40	5.00	5.00	6.25
Sat.	27	5.40	6.10	5.00	6.25
Sun.	28	5.50	6.10	5.00	6.25
Mon.	29	5.50	6.10	5.05	6.15
Tue.	30	5.50 NM	6.10	5.05	6.15
Wed.	31	5.50	6.10	5.05	6.15



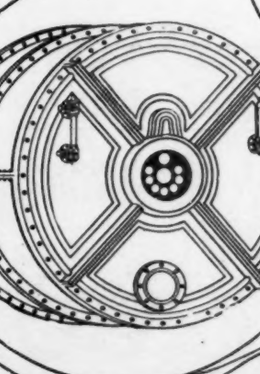


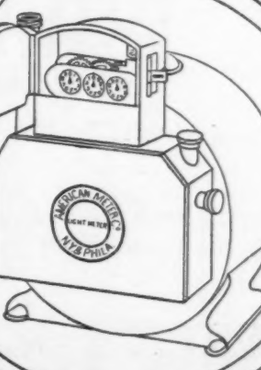




TOTAL HOURS LIGHTING DURING 1900.

By Table No. 1.	Hrs. Min.	By Table No. 2.	Hrs. Min.
January	230.50	January	423.20
February	175.40	February	355.25
March	189.00	March	355.35
April	160.30	April	298.50
May	150.40	May	264.50
June	137.00	June	234.25
July	152.00	July	243.45
August	171.50	August	280.25
September	187.20	September	321.15
October	213.10	October	374.30
November	221.50	November	401.40
December	231.50	December	433.45
Total, yr.	2221.40	Total, yr.	3987.45





THE RECENT DECISION.

The United States Circuit Court of Appeals,

In Its Opinion of December 7, 1899,

FINALLY AND FULLY SUSTAINS THE WELSBACH COMPANY'S PATENT.

DEALERS and USERS and MANUFACTURERS are CAUTIONED against INFRINGEMENT of the

Welsbach Patents.

Judge LACOMBE, in the United States Circuit Court, handed down the following opinion Saturday, Dec. 9, 1899.

On motion to restrain complainant from sending circulars to the customers of American Incandescent Lamp Company.

LACOMBE, Circuit Judge.

Irrespective entirely of the preliminary objection that affirmative relief of this sort will not be granted to defendant—a question not now passed upon—there seem no good grounds for criticism of complainant's circular. It states that Judge Townsend enjoined the "manufacture and sale" of infringing mantles, and he did grant such an injunction. And this Court has enjoined the sale of mantles which the person enjoined did not himself manufacture, when his past conduct in the matter of infringement created a special equity in favor of the complainant against him. It is true that the circular goes further, and threatens suit against persons who sell mantles, but who never have been at all concerned in manufacturing or causing them to be manufactured.

In other words, it threatens suit upon the patent as if it were a patent for a product. But the complainant insists that the threat is made in good faith; that it intends to bring suits against sellers of the infringing mantles upon the theory that the patent is really one for a product. In view of the peculiar language of the claim, this Court is not now prepared to hold that such contention would be wholly without merit, or that the complainant could not succeed against a mere seller. Moreover, it is contended that the seller of a purchased mantle himself promotes the taking of the final step in the process, and such contention has not yet been passed upon adversely to complainant. These are questions which should be left to be determined in one of such suits, rather than here. If complainant intends to prosecute one or more sellers, and there is nothing before the Court to induce a disbelief in its assertion that it does so intend, it would seem to be its proper course to warn dealers to desist from selling.

December 9, 1899.

Restraining orders issued in the United States Circuit Courts against—

THE UNITED INCANDESCENT LIGHT COMPANY.
ST. LOUIS INCANDESCENT MANTLE COMPANY.
ECKERLE ELECTRICAL COMPANY.
H. KUPFER.
THE NEWBY INCANDESCENT MANTLE COMPANY.

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Lowell, Mass.	1	1,000,000 "
Doylestown, Pa.	1	50,000 "
Darby, Pa.	1	400,000 "
Adrian, Mich.	1	125,000 "
Concord, N. H.	1	400,000 "
Sioux City, Iowa	1	750,000 "
Standard Gas Light Co., New York	3	5,400,000 "
Peekskill, N. Y.	1	250,000 "
Westchester, N. Y.	1	250,000 "
Jersey City, N. J.	1	1,000,000 "
Stapleton, N. Y.	1	750,000 "
London, O.	1	125,000 "
Chicago, Ills.	2	3,600,000 "
Putnam, Conn.	1	125,000 "
Mansfield, O.	1	250,000 "
Plymouth, Pa.	1	125,000 "
Athens, Pa.	1	125,000 "
Charlotte, N. C.	1	250,000 "
Consolidated Gas Co., New York	2	2,000,000 "
Quincy, Ills.	1	250,000 "
Boone, Ia.	1	125,000 "
Webster, Mass.	1	50,000 "
Flushing, N. Y.	1	250,000 "
Total	29	18,650,000 "
Previously built	294	187,100,000 "
Grand Total	323	205,750,000 "

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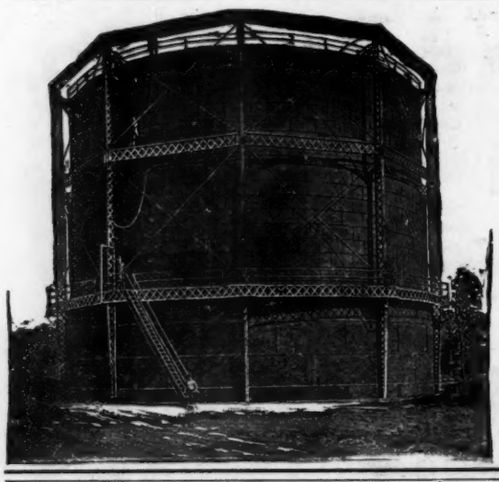

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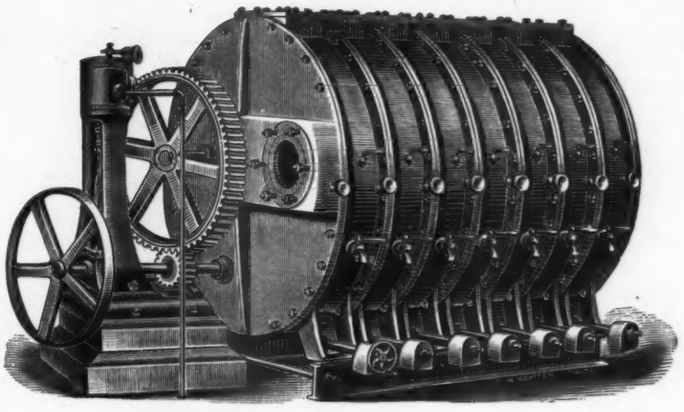

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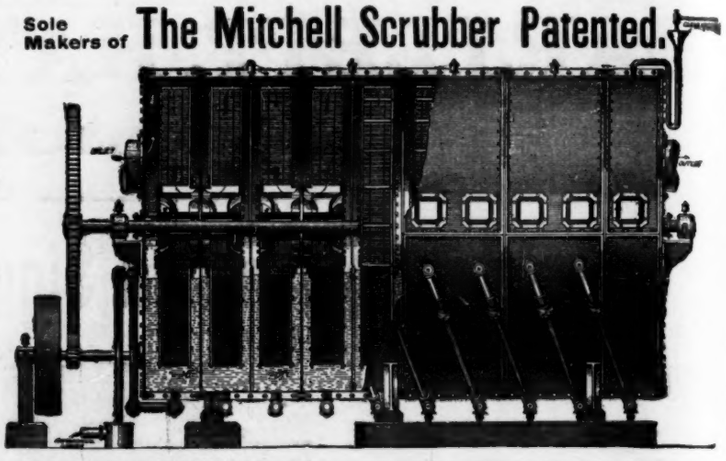

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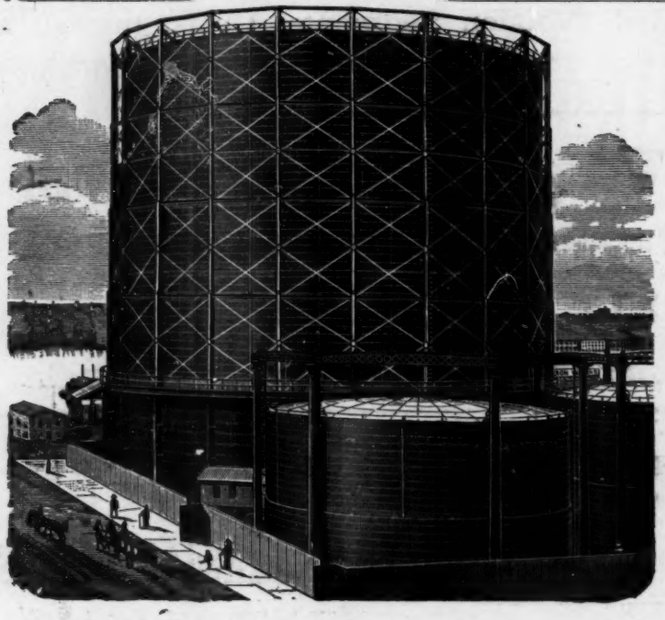

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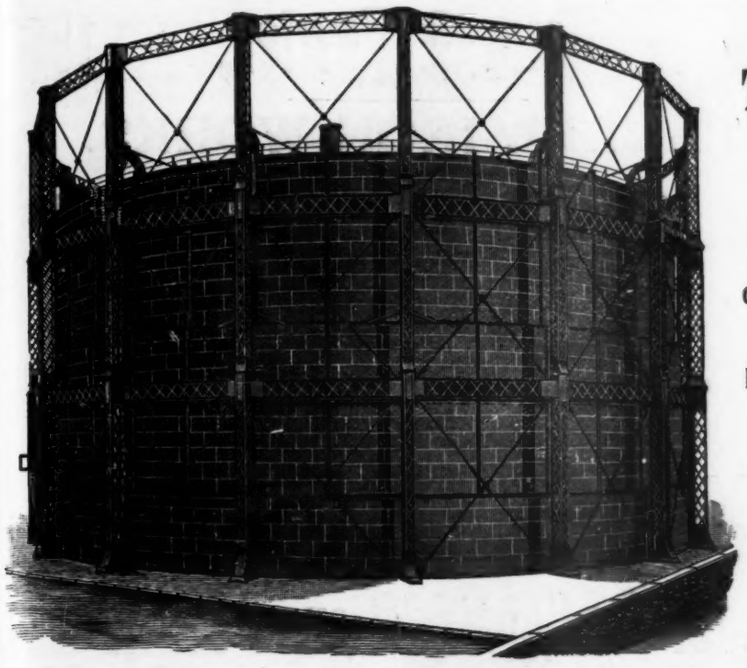

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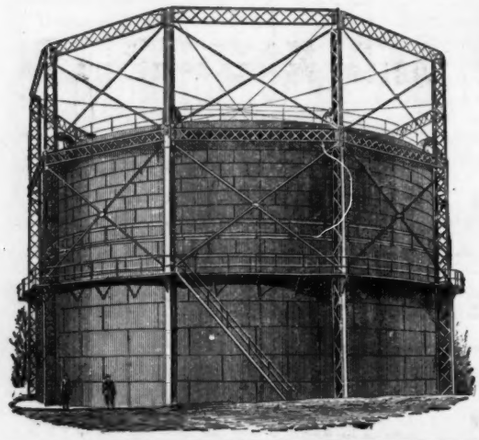

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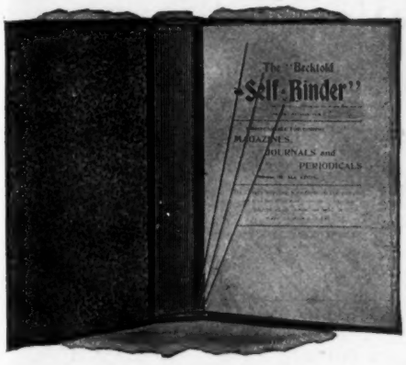

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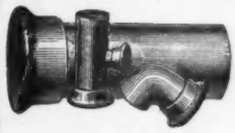

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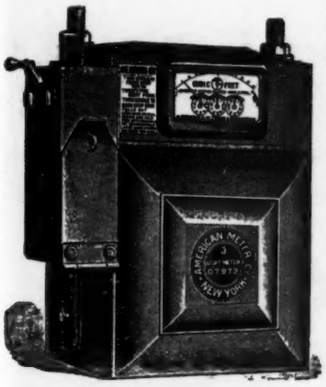

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